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Annotated Bibliography of

**Strontium and Calcium
Metabolism
in
Man and Animals**

Miscellaneous Publication No. 821

AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE



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Compiled by R. H. Wasserman and C. L. Comar

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AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D.C.

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CONTENTS

	Page		Page
General references.....	1	Factors affecting strontium and calcium metabo-	
General metabolism of strontium and calcium.....	4	lism.....	53
Comparative metabolism of strontium and		Dietary levels of calcium and phosphorus.....	53
calcium.....	4	Vitamins.....	59
Gastrointestinal absorption of strontium and		Vitamin D.....	59
calcium.....	8	Other vitamins.....	68
Availability of calcium from dietary sources....	12	Hormones.....	69
Distribution and movement of strontium and		General.....	69
calcium in the animal body.....	14	Parathyroid hormone.....	69
Excretion and turnover of strontium and		Estrogens, cortisone, and other steroids....	74
calcium.....	19	Thyroid hormone.....	77
Metabolism of strontium and calcium in		Hypophyseal and other hormones.....	78
specific tissues other than the bone.....	25	Gestation and lactation.....	78
Metabolism of strontium and calcium in hard		Age.....	85
tissues.....	28	Fluorides.....	86
Metabolism and deposition of strontium and		Complexing agents (as phytates and citrates)....	88
calcium in the skeleton.....	28	Miscellaneous factors.....	90
Deposition of strontium and calcium in		The fallout problem.....	94
the skeleton.....	28	General.....	94
Bone-salt metabolism and growth proc-		Theoretical aspects.....	95
esses of the bone.....	33	Toxicological aspects of radiostrontium.....	97
Ion-exchange reactions of the skeleton....	39	Acute and chronic toxicity.....	97
Calcification mechanisms.....	41	Carcinogenicity.....	103
Strontium rickets.....	45	Methods of removal of radiostrontium from	
Tissue composition.....	46	the animal body.....	107
Metabolism and deposition of strontium and		Analytical methods.....	111
calcium in the teeth.....	49	Subject index.....	116
Deposition of strontium and calcium in the		Author index.....	129
egg and metabolism in the egg-laying			
process.....	51		

Annotated Bibliography of Strontium and Calcium Metabolism in Man and Animals

Compiled by R. H. WASSERMAN and C. L. COMAR,
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Within recent years it has become necessary to understand the metabolism and movement of radioactive strontium in the biosphere. The behavior of strontium in man and animals is closely linked with that of calcium, and it is therefore necessary to consider the factors that govern the behavior of both elements. Many subject areas are involved either directly or indirectly; for example, nutrition, bone physiology, gestation, lactation, vitamin action, and hormone action. This is apparent from the vast and frequently confusing literature on calcium itself. Thus it is often most difficult for an individual or a research group to acquire an integrated and adequate background for the study of strontium and calcium metabolism.

This annotated bibliography was compiled and systematized to provide a ready source of pertinent published material and to call attention to important peripheral subject areas. It should be useful to national defense workers who are doing research on the strontium-calcium relationship. No attempt has been made to cover the literature exhaustively, since each subject area, especially for normal calcium metabolism, would require hundreds or thousands of references. Therefore, representative references have been included so as to indicate the present status of knowledge of,

and the relationship of pertinent subject areas to, strontium and calcium metabolism.

The abstracts have been classified by major category and arranged therein alphabetically by author. In usage it is suggested that the major category of interest be consulted first and then reference made to the subject index for specific items.

The final preparation was supported under contract with the Animal Disease and Parasite Research Division, Agricultural Research Service, U.S. Department of Agriculture. Cornell University was responsible for the compilation and the editing of the references and the abstracts; the Department of Agriculture was responsible only for the publication of this bibliography. Other agencies were most helpful and encouraging, especially the U.S. Atomic Energy Commission and the U.S. Department of the Army. Librarians of the New York State Veterinary College and the Oak Ridge Institute of Nuclear Studies rendered invaluable aid. Abstracting and literature search were done by M. M. Nold, A. R. Twardock, and L. Wood of the New York State Veterinary College. Grateful acknowledgment is made to these and other persons who helped so much, as well as to the sources of the abstracts noted in certain entries.

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GENERAL METABOLISM OF STRONTIUM AND CALCIUM

COMPARATIVE METABOLISM OF STRONTIUM AND CALCIUM

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edge of the BRF, the Sr:Ca ratio of the diet, and the level of radio-Sr contamination." (Chem. Abs. 50: 8001.)

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"A 5-month-old puppy was simultaneously given radium and calcium-45 intravenously and sacrificed 24 hours later. Serial sawed cross sections of the tibia were prepared, radioautographed, and samples of cortical bone of various ages as well as primary and secondary spongiosa were collected. These samples as well as aliquots from a longitudinally segmented humerus were separately analyzed for both Ca^{45} and Ra^{226} content. These data revealed a lower proportion of Ra^{226} compared to Ca^{45} in the completely calcified cortical bone than in newly forming bone. In comparing the relative amounts of Ca^{45} and Ra^{226} in the plasma integrated over the experimental period, the following conclusions are made:

(1) Ra^{226} must be in higher concentration in the extracellular fluid of bone than in blood, or forming bone concentrates over 1.7 times as much Ra^{226} as Ca^{45} .

(2) Ca^{45} is preferentially fixed in old cortical bone due to less extensive incorporation of Ra^{226} in the recrystallization process.

(3) Radium is probably preferentially bound in the exchangeable fraction of bone mineral." (Author's summary.)

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Analysis of the stable strontium and strontium-90 content of foods in Wales and the west and north of England enables an estimate of the average intake in diet. The mean strontium-90/calcium ratio in the adult diet in the summer of 1957 was $5.6 \mu\text{c./g.}$, about the same as the ratio in milk alone. Individuals who obtain their milk and other food supplies from farms with high rainfall and acid- or calcium-deficient soils may have signifi-

cantly higher strontium-90/calcium ratios in their diets, but the extreme variation is unlikely to exceed a factor of 5. The mean stable strontium/calcium ratio in the diet was $1,200 \mu\text{g./g.}$, about four times the corresponding ratio in milk. There appears to be a discrimination of about 4:1 against strontium in favor of calcium in uptake from food to human bone. The strontium-90/calcium (S.U.) ratio in newly laid down bone is deduced to be between 1 and 2 S.U. for individuals on mixed diets.

81. COMAR, C. L., RUSSELL, R. S., and WASSERMAN, R. H. Strontium-calcium movement from soil to man. *Science* 126: 485-492. 1957.

"Radiostrontium moves similarly to calcium in food chains, is well absorbed by plants, animals, and man; is deposited and retained in bones; is transmitted to milk and to the developing fetus; and is known to cause bone tumors and is suspected of causing leukemia. Megaton nuclear explosions result in a large fraction of the Sr^{90} formed being deposited in the stratosphere. This material slowly passes back into the troposphere with an average residence in the stratosphere of about 10 years. Kiloton weapons deposit their Sr^{90} in the troposphere. Radioactivity in the troposphere, regardless of origin, is relatively quickly deposited on the surface of the earth, primarily by precipitation. The comparative movement of Sr and Ca in biological systems is discussed. Findings related to the differential behavior of the two elements are reviewed. The data are intended to serve as a basis for predicting the levels of Sr^{90} to be expected when the soil content and dietary intake can be estimated." (*Nuclear Sci. Abs.* 11: 11888.)

82. COMAR, C. L., and WASSERMAN, R. H. Strontium-calcium metabolism in man and animals as studied by radioisotope methods. *Internatl. Jour. Appl. Radiation and Isotopes* 2: 247. 1957.

"The need for information on the comparative metabolism of strontium and calcium has led to the development of physical and physiological procedures based on double tracer techniques, which are of general interest. Radiochemical and other methods have permitted the simultaneous estimation of various combinations of the following isotopes: Sr^{89} , Sr^{90} , Sr^{85} , Ca^{45} , Ca^{40} . The studies have been done on man, rats, rabbits, and goats. The physiological techniques have included single dosage, ingestion with meals over extended periods, comparative clearance studies, and isolation of individual processes by nephrectomy or short-term collections of bile and intestinal contents. In addition to determination of the overall quantitative behavior of strontium and calcium, the contributions of the following processes to the total discrimination have been estimated: Absorption from the gastrointestinal tract, urinary excretion, secretion into milk, endogenous excretion, biliary excretion, bone accretion and resorption, and transfer across the placental barrier. Double tracer studies have permitted convenient study of the effect of the following factors on comparative strontium-calcium metabolism: Age, level of calcium in diet, and complexing agents. Data are presented on all points mentioned above." (Author's abstract.)

83. COMAR, C. L., WASSERMAN, R. H., and NOLD, M. M. Strontium-calcium discrimination factors in the rat. *Soc. Expt. Biol. and Med. Proc.* 92: 859-863. 1956.

"The term strontium-calcium observed ratio (OR) is proposed and defined to designate the over-all discrimination that occurs in movement of the 2 elements from one phase to another in a biol. system. The term strontium-calcium discrimination factor (DF) is proposed and defined as the contribution of individual processes to the over-all discrimination. Double tracer studies of radioactive Ca and Sr over a 20-day period gave the same OR values as methods based on lifetime feeding. Absorption from the digestive tract and urinary excretion were the main processes by which the rat discriminated against dietary Sr in favor of Ca. The renal clearance of Sr was 3-5 times that of Ca. There was evidence of slight Sr preference in

movement of the 2 elements from blood to bone. Excretion into the gastrointestinal tract did not contribute significantly to the over-all discrimination." (Chem. Abs. 51: 2148.)

84. COMAR, C. L., and others. Strontium metabolism and strontium-calcium discrimination in man. Soc. Expt. Biol. and Med. Proc. 95: 386-391. 1957.

R. H. Wasserman, S. Ullberg, and G. A. Andrews, joint authors.

"Patients chronically ill with leukemia or widespread malignant neoplasms were given small oral doses of carrier-free Sr^{90} (cyclotron-produced from Rb, 65 day half-life, no β rays, 0.013 m.e.v. x-ray, 0.513 γ -ray) and Ca^{45} . The studies indicate that the behavior of radiostromium in man is similar to that in exptl. animals. When ingested in water soln. by adults, about 74% was excreted via the feces and 6% in the urine. Absorption occurred mainly within 4 hrs. after ingestion. Values are given for the plasma and urinary levels attained at steady state under conditions of ingestion with milk at each meal. When Sr^{90} and Ca^{45} were fed simultaneously in milk at each meal for several days there was a discrimination against Sr by a factor of about 2; this resulted from preferential absorption of Ca and preferential urinary excretion of Sr." (Chem. Abs. 51: 14956.)

85. COMAR, C. L., WHITNEY, I. B., and LENGEMANN, F. W. Comparative utilization of dietary Sr^{90} and calcium by developing rat fetus and growing rat. Soc. Expt. Biol. and Med. Proc. 88: 232-236. 1955.

"A diet contg. 1.9% Ca and a very small amt. of carrier-free Sr^{90} Cl_2 was fed. Continuous feeding expts. indicated that dietary Ca was utilized by growing rats for bone growth by a factor of 3.6 over Sr^{90} . Examn. of fetuses showed that about 28% of the fetal Ca was derived from maternal skeletal Ca, and that the Ca of the mother diet was utilized for bone formation in the developing fetus by a factor of 5.1 over Sr^{90} . This high factor for the fetus was accounted for on the basis that Ca and Sr^{90} released from the maternal skeleton were deposited in the fetus with the same selectivity of 3.6 for Ca as was observed in the growing rat." (Chem. Abs. 49: 7076.)

86. GREENBERG, D. M., and TROESCHER, F. M. Study with radioactive isotopes of excretion of calcium and strontium by way of bile. Soc. Expt. Biol. and Med. Proc. 49: 488-491. 1942.

"Between 4 and 5% of an injected dose of labeled Sr or Ca is eliminated with the bile in the first 3 days in rats with bile fistula." (Chem. Abs. 36: 3554.)

87. HEITE, H. J., HINRICHS, K., and REMKY, H. Comparative investigations of Ca and Sr in their effect on closing off the membranes of the blood-chamber fluid barrier of the rabbit eye. Klin. Wchnschr. 31: 333-336. 1953.

"Ca gluconate was effective in 4 out of 11 rabbits for 2-4 hrs. and Sr in all of 12 rabbits for 7 hrs. in closing the blood-chamber fluid barrier after pilocarpine treatment." (Chem. Abs. 47: 7099.)

88. HELMICK, M. J. Comparative uptake and retention of radioactive calcium and strontium in the skeleton of adult rats. U.S. Atomic Energy Comm. AECU-3261, p. 44-56. 1956.

89. KIKUCHI, T., and others. The metabolism of fission products. III. Radioautographic studies on the localization of radiostromium and radiocalcium in the bones. Kyoto Univ. Inst. Chem. Res. Bul., sup. issue, Nov. 1954, p. 99-105. 1954.

G. Wakisaka, M. Suenaga, T. Kono, H. Akagi, H. Goto, T. Matsuki, and Y. Yoshimine, joint authors.

"Distribution of Sr^{90} , Sr^{90} and Ca^{45} in the bones of mice and guinea pigs was studied by a radioautographic method. Both groups of elements were found in heavy d. in the bones, particularly in the epiphysis. The distribution of radio-Ca in the bones adjacent to the knee joint, 10 hrs.

following intracardial injection of 15 microcuries of Ca^{45} in adult guinea pigs, was $2.84 \pm 0.12\%$ of the administered dose per g. tissue. The serum radio-Ca level per cc. measured under the same conditions was $0.038 \pm 0.01\%$ of the administered dose. No remarkable change in blood picture was observed in the period of 5 days following intracardial administration of 15 microcuries of Ca^{45} in guinea pigs." (Chem. Abs. 49: 5138.)

90. LENGEMANN, F. W. Comparative metabolism of Sr^{90} and Ca^{45} by bone grown *in vitro*. Soc. Expt. Biol. and Med. Proc. 94: 64-66. 1957.

"Chick embryo bones cultured *in vitro* took up Sr^{90} slightly faster than Ca^{45} during the first 2 hrs. of contact. They also released Sr^{90} a little faster than Ca^{45} when placed in fresh medium." (Chem. Abs. 51: 10694.)

91. MacDONALD, N. S., NOYES, P., and LORICK, P. C. Discrimination of calcium and strontium by the kidney. Amer. Jour. Physiol. 188: 131-136. 1957.

"Skeletal retention and excretion of Sr were directly compared with those of Ca by injecting solns. contg. both Ca^{45} and Sr^{90} into rats and rabbits. In normal animals, a greater fraction of the injected dose of Ca^{45} was retained in the skeleton than was observed for Sr^{90} . The fraction of the injected Sr^{90} which appeared in the urine was greater than the fraction of the dose of Ca^{45} which was excreted. However, in rats which were actively calcifying tibial fractures, this difference disappeared. The enhanced accumulation of radioactivity in deposits of new bone possessed the same ratio of $\text{Sr}^{90}:\text{Ca}^{45}$ as the soln. injected. When the functions of the kidneys of normal rabbits were impaired by poisoning with HgCl_2 or were completely extinguished by nephrectomy, again the usual difference in Ca^{45} and Sr^{90} deposition in bone tissue disappeared. When plasma contg. both Ca^{45} and Sr^{90} was shaken with powd. bone, both radioisotopes were extd. in equiv. amts." (Chem. Abs. 51: S304.)

92. NORRIS, W. P., and KISIELESKI, W. E. Comparative metabolism of radium, strontium, and calcium. Cold Spring Harbor Symp. Quantit. Biol. 13: 164-172. 1948.

"Rats were injected intravenously with either Ca^{45} , Sr^{90} , Ra^{226} in equil. with the radioactive Y^{90} daughter of Sr^{90} , or Ra. The radioactive materials were administered as the chlorides in isotonic solns. at pH 3 to 4. Each rat received 0.5 ml. The quantities of radioactivity administered to each rat in the various expts. were 40 $\mu\text{c.}$ of Ca^{45} (1.5 mg. Ca^{40}), 115 $\mu\text{c.}$ of Sr^{90} , Ra^{226} and 25 $\mu\text{c.}$ of Ra, resp. Urinary and fecal excretion of the alk. earths proceeded very rapidly. With Ca and Ra, about 50% of the total excretion occurred in the first day. With Sr, somewhat less than 30% of the total excretion took place in the first 24 hrs. The rate of elimination of Ra in both urine and feces was observed to decrease exponentially with a slope, very close to -1.5 in either case. The max. concns. in the blood, following the intravenous administration of either Ca, Sr, or Ra, were obtained at the earliest examd. interval after injection. Values were taken with whole blood in the case of Sr and Ra and with serum in the case of Ca. The blood concn. of Sr appeared to remain significantly above that of either Ca or Ra at all times. Intravenous injection of the alk. earths was followed by a rapid uptake of these materials in bone. The bones reached their max. content in approx. 100 min. for all 3 materials. A study of the metabolism of Ra injected intraperitoneally into a series of rats was reported. Total body retention of Ra was measured in 100 rats at injection levels ranging from 0.93 to 0.02 $\mu\text{c./g.}$ The calcd. excretion of Ra by these rats between the 10th and 300th days was only 3.7%. Excretion between the 10th and 20th days was 1.4%. Retention of Ra in the rat increased with increase of injected amt." (Chem. Abs. 49: 4755.)

93. PECHER, C. Biological investigations with radioactive calcium and strontium. Soc. Expt. Biol. and Med. Proc. 46: 86-91. 1941.

"Salts of radioactive Ca^{45} and radioactive Sr^{90} (contg. a little radioactive Y) were injected into mice. The Ca

was taken up by the tissues more readily than the Sr but the distribution among the different tissues was almost the same for both elements. Both were concd. in the skeleton, the digestive tract contained appreciable amts., the concn. in the liver and other soft tissues was very low and there was almost none in the fat. In the leg bones the epiphysis showed more activity than the diaphysis. The vertebrae showed more activity than most of the other bones. Radioactive compds. were excreted in both the urine and the feces." (Chem. Abs. 35: 2191.)

94. ROSENTHAL, H. L. The metabolism of strontium-90 and calcium-45 by Lebistes. Biol. Bul. 113: 442-450. 1957.

"Uptake and turnover of Sr⁹⁰ by various tissues in the guppy were detd. and compared with similar data for Ca⁴⁵ (C.A. 51, 3054c). Incorporation of Sr⁹⁰ was rapid and linear for all concns. of isotope used during the 10- or 15-day exptl. periods, the rate of accumulation being greater in osseous tissue (spine and head) than in soft tissue (viscera and muscle). After 10 days in H₂O contg. Sr⁹⁰, fish were placed in isotope-free H₂O; loss of Sr⁹⁰ was most rapid for viscera, 92% of radioactivity being lost in 2 days. Turnover for muscle was extremely slow. The spine continued to incorporate isotope for 10 days and subsequently to lose it slowly." (Chem. Abs. 52: 8393.)

95. ROSENTHAL, H. L. Uptake of calcium-45 and strontium-90 from water by fresh-water fishes. Science 126: 699-700. 1957.

The uptake of Ca⁴⁵ and Sr⁹⁰ by fresh-water fishes from water was linear with respect to time. No difference in the uptake of the two radionuclides Ca⁴⁵ and Sr⁹⁰ was observed. When the data were expressed in terms of either body weight or body calcium concentration, there was no species difference in the rate of uptake of Ca⁴⁵ from water.

96. ROSENTHAL, H. L. Comparative uptake of calcium-45 and strontium-90 by wild and lordotic guppies. Soc. Expt. Biol. and Med. Proc. 97: 624-627. 1958.

"The lordotic mutation in the guppy is associated with a lower accumulation of body calcium and increased incorporation of calcium into bone. Strontium incorporation is the same for both strains of fishes. These studies indicate a specific defect in calcium metabolism and may further an understanding of calcium metabolism and bone formation." (Author's summary.)

97. SAMACHSON, J., and others. Passage of calcium and strontium ions through membranes. Fed. Proc. 16: 241. 1957.

H. Spencer, B. Kabakow, and D. Laszlo, joint authors.

"Discrimination in favor of calcium against strontium has been found with regard to absorption in plants, animals, and man. This discrimination plays an important role in assessing the toxicity of radiostrontium to man. It was of interest to study whether it is related to the physical-chemical properties of the ions involved, such as the ability to pass through membranes. Ca⁴⁵ and Sr⁸⁵ were added to serum, and the passage of calcium and strontium ions through Visking casings was studied in vitro. A higher percentage of strontium than of calcium filtered through the membrane. Almost invariably, also, filtration of both ions was greater at room temperature (about 22-25° C.) than at body temperature. In vivo studies were also made of the transfer of calcium and strontium from plasma to other body fluids, such as peritoneal and cerebrospinal fluid. Different transfer rates were noted for calcium and strontium from plasma to peritoneal fluid; these rates were apparently dependent on the protein content and composition of the various fluids. The transfer of these ions from plasma to cerebrospinal fluid was studied in 10 patients. The calcium content of the fluid was approximately 55 percent of the calcium present in the plasma, whereas the ratio of strontium was significantly lower. The implication of these results with regard to protein binding of calcium and strontium, excretion of

strontium, and deposition of radioactive strontium in bone are discussed." (Author's abstract.)

98. SCHULERT, A., and others. Strontium-calcium fractionation in man. Amer. Chem. Soc. Abs. of Papers, 130th Meeting, p. 49c. 1956.

M. Charles, E. Peets, W. R. Eckelmann, and D. Laszlo, joint authors.

Tracer quantities of Sr⁸⁵ gamma emitter and beta emitter Ca⁴⁵ in the chloride form were administered intravenously to terminal cancer patients. At autopsy, samples of many tissues were analyzed for Sr⁸⁵, Ca⁴⁵, and total Ca. Methods of analysis are described. At 3 days after injection, 72 percent of Ca and 52 percent of Sr were in bone. There was less Ca than Sr in soft tissues. After 30 days, as in bone, more Sr was eliminated from soft tissues than Ca, and Ca concentration was higher. Data revealed that the biological half life of Ca was much greater than that of Sr. Concentration of Sr per gram of dry tissues was 50 times greater in bone than in soft tissues 39 days after injection. Specific activity (concentration of isotopes per gram of Ca) was greatest in soft tissues. Variation of isotope concentration within a given bone is discussed.

99. SINGER, L., and others. Endogenous and biliary excretion of calcium-45 and strontium-89. Arch. Biochem. and Biophys. 66: 404-410. 1957.

M. Maqsood, A. B. Medlen, and C. L. Comar, joint authors.

"Short-term appearance of intravenously injected Ca⁴⁵ and Sr⁸⁹ in isolated segments of the gastrointestinal tract of the dog was detd. Both isotopes were excreted into all parts of the tract; about 20% more Sr⁸⁹ was found than Ca⁴⁵. About 75% of excreted Sr⁸⁹ and 50% of excreted Ca⁴⁵ was found in the small intestine; for the large intestine the values were about 20% for Sr⁸⁹ and 40% for Ca⁴⁵. About 6-9% of the Ca⁴⁵ and Sr⁸⁹ excreted into the tract was derived from the bile. By direct comparison, the amt. of biliary Sr⁸⁹ was almost twice that of biliary Ca⁴⁵." (Chem. Abs. 51: 9001.)

100. SPENCER, H., LASZLO, D., and BROTHERS, M. Strontium and calcium metabolism in man. Jour. Clin. Invest. 36: 680-688. 1957.

"The metabolism of an orally administered tracer of Sr⁸⁵ was studied in 6 patients with carcinoma metastases in bone and compared with that of an intravenous tracer in 4 patients. The metabolism of an orally administered tracer dose of Ca⁴⁵ and Sr⁸⁵ was studied in 2 patients. The main pathway of excretion of Sr⁸⁵ is via the kidney irrespective of the route of administration, and the urinary Sr⁸⁵ excretion differs in various subjects depending on the state of metabolism of the skeleton. Another pathway of excretion of Sr is the intestinal tract; approx. 10% being thus eliminated as endogenous fecal Sr. The absorption of ingested Sr⁸⁵ was detd. by subtracting the endogenous fecal Sr from the stool radioactivity. Sr is poorly absorbed from the gastrointestinal tract, an av. of 80% passing unabsorbed. The metabolism of the absorbed fraction of the oral dose of Sr⁸⁵ agreed well with that of the intravenous dose. The body load of Sr is approx. 4-6 times higher after the intravenous dose than after the oral dose. Comparison of the metabolism of oral Sr⁸⁵ and Ca⁴⁵ revealed that Ca is better absorbed than Sr, the latter being preferentially excreted. For these reasons, less Sr than Ca remains in the human body. Sr cannot be used as an accurate measure for Ca metabolism. 29 references." (Chem. Abs. 51: 14096.)

101. SPENCER, H., SAMACHSON, J., and LASZLO, D. Metabolism of Sr⁸⁵ and Ca⁴⁵ in man. Fed. Proc. 17: 154. 1958.

"Data are presented on the comparative metabolism of Sr⁸⁵ and Ca⁴⁵ in 18 patients receiving a constant dietary intake under controlled conditions on the metabolic research ward. These studies lasted 124 days. A single dose of both tracers was given orally to 14 patients and intravenously to 4. Urinary and fecal Sr⁸⁵ and Ca⁴⁵ excre-

tions were determined daily for the duration of each study and plasma levels as long as significant counts could be obtained with the equipment used. Dissimilarities, rather than similarities of the metabolism of the two elements, were noted, especially in terms of absorption and urinary excretion. The absorption of Sr^{85} was significantly lower than that of Ca^{45} in 12 of 14 patients. Furthermore, the rate of urinary Sr^{85} excretion was considerably higher than that of Ca^{45} excretion; the renal clearance of Sr^{85} was four to five times as high as that of Ca^{45} . Due to the poor absorption of radiostrontium from the gastrointestinal tract and its preferential excretion through the kidney, the body burden of Sr^{85} was considerably lower than that of Ca^{45} . Acute lowering or elevation of the serum calcium level and prolonged supplementation of calcium to the diet (calcium gluconate, whole and skimmed milk) had no effect on intestinal absorption of Sr^{85} ." (Authors' abstract.)

102. STOVER, B. J., ATHERTON, D. R., and ARNOLD, J. S. Comparative metabolism of Ca^{45} and Ra^{226} . Soc. Expt. Biol. and Med. Proc. 94: 269-272. 1957.

"The comparative metabolism of Ca^{45} and Ra^{226} was studied in a young dog. Ra^{226} left the blood more rapidly than Ca^{45} ; this is ascribed partly to a preferential excretion by the kidneys and gut. Retention of both elements was greater than 90%, consistent with the fact that the skeleton was rapidly growing. Analysis of the individual bones revealed no significant difference in the relative deposition of the two, but the teeth showed a preferential uptake of Ca." (Chem. Abs. 51: 8158.)

103. THOMPSON, T. G., and CHOW, T. J. Strontium-calcium atom ratio in carbonate-secreting marine organisms. Wash. [State] Univ. Pubs. Oceanog. 184: 20-39. 1955.

"The Ca and Sr content in the shells of 250 species of CO_2 -secreting marine organisms, as detd. by Boggild (*Kgl. Danske Videnskab. Selskabs. Skrifter Naturvidenskab. math. Afdel.*, 2, 231 (1930)), by Vinogradov (*The Elementary Chemical Composition of Marine Organisms* 1953 (C.A. 48, 10091d)), and by Chave (C.A. 48, 8138e) were converted to Sr-Ca atom ratios. The organisms, together with the range in (Sr/Ca) X 1000 values, were: marine algae 2.9-3.4, protozoans 2.8-3.3, sponges 2.3-3.3, coelenterates 2.6-11.2, annelids 3.9-8.2, arthropods 3.8-6.7, mollusks 7.8-9.2, amphineura 7.3-8.6, pelecypods 1.0-2.9, gastropods 1.2-2.5, scaphopods 3.7, bryozoans 3.0-3.9, brachiopods 1.3-1.6, echinoderms 2.6-2.9, and chordates 1.0-2.8. The marine organisms living in the same ecological niche accumulated Ca and Sr in their shells in decidedly different proportions. H_2O temp. did not affect the Sr-Ca atom ratios in the shells. The majority of the specimens had CaCO_3 existing as calcite, some had a calcite-aragonite mixture and others aragonite or phosphorite. The shells consisting of aragonite had more Sr than did those of calcite." (Chem. Abs. 52: 591.)

104. THURBER, D. L., and others. Common strontium content of the human skeleton. Science 128: 256-257. 1958.

J. L. Kulp, E. Hodges, P. W. Gast, and J. M. Wampler, joint authors.

Survey analyses indicate that a worldwide value of percent Sr/percent $\text{Ca} \times 10^3$ is 0.45 ± 1 in human bone and 7 ± 1 in rock or soil. From these values it is predicted that the overall Sr/Ca discrimination from soil and plant to human bone is about 16.

105. VAN CLEAVE, C. D., and KAYLOR, C. T. Strontium/calcium ratios in parts of rat femur. Soc. Expt. Biol. and Med. Proc. 98: 623-625. 1958.

"After intraperitoneal injection of a mixture of Ca^{45} and Sr^{89} in the rat, the Sr/Ca observed ratio in parts of a long bone, the femur, was obtained 15 minutes to 48 hours after injection. A maximal Sr content appeared in bone within 30 minutes, with the shaft showing discrimination against Ca. During the next 48 hours the observed ratios fell but remained consistently higher in the shaft areas of the

bone. Data on blood Sr/Ca ratios are also presented." (Authors' summary.)

106. WASSERMAN, R. H., and others. Placental transfer of calcium and strontium in the rat and rabbit. Amer. Jour. Physiol. 189: 91-97. 1957.

C. L. Comar, M. M. Nold, and F. W. Lengemann, joint authors.

"The comparative metabolism of Ca and Sr during fetal development was studied in rats and rabbits by means of double tracer techniques. The placental transfer from dam to fetus of Sr was about $\frac{1}{2}$ that of Ca; the site of discrimination was the placental barrier. The major discrimination occurred in movement of Ca^{45} and Sr^{85} from dam to fetus, with little or no differential movement from fetus to dam. Under steady state conditions in the rat the relative $\text{Sr}^{85}/\text{Ca}^{45}$ ratios in the fetus, maternal skeleton and diet were 0.17, 0.28, and 1, resp. In the rat it was estd. that 92% of the fetal Ca had originated from the maternal diet. In the rabbit during late pregnancy about 24 mg. of Ca/fetus/day moved across the placenta as compared with a need of about 13 mg. for fetal development." (Chem. Abs. 51: 13150.)

GASTROINTESTINAL ABSORPTION OF STRONTIUM AND CALCIUM

107. BLAU, M., and others. Utilization and intestinal excretion of calcium in man. Science 120: 1029-1031. 1954.

H. Spencer, J. Swernov, and D. Laszlo, joint authors. "By simultaneous measurements of Ca^{45} and total Ca balances in 2 patients it was possible to measure the rates of absorption and excretion of Ca. The endogenous fecal Ca amounted to 91 and 117 mg./day, resp., whereas the unabsorbed food Ca was found to be 60 and 45 mg./day. The total amount of Ca excreted in the digestive juices was calcd. to be 160 and 370 mg./day." (Chem. Abs. 49: 4850.)

108. BOROUGHS, H., TOWNSLEY, S. J., and HIATT, R. W. Metabolism of radionuclides by marine organisms. III. The uptake of calcium 45 in solution by marine fish. Limnol. and Oceanog. 2: 28-32. 1957.

"*Tilapia mossambica*, sluggish marine or brackish water fish, were put in artificial sea water with calcium 45. The total calcium concentration was equal to that of sea water. The fish were not fed during the experiment, which lasted 21 days. During this time the fish took up the Ca^{45} to the extent of about 60 percent of the Ca^{45} concentration in the water. Most of the radioactivity was recovered in the skeleton and integument, but the values obtained do not correspond to the elemental analysis of various fish for calcium. Only a small percentage of the body calcium is apparently readily exchangeable. It is concluded that marine fish can take up calcium directly from sea water and do not need a dietary source for this element. In comparison with a similar experiment using radiostrontium, it is further concluded that marine fish discriminate against strontium in favor of calcium." (Authors' summary.)

109. BRINE, C. L., and JOHNSTON, F. A. Factors affecting calcium absorption by adults. Amer. Dietet. Assoc. Jour. 31: 833-838. 1955.

"A review. 42 references." (Chem. Abs. 49: 16100.)

110. BRONNER, F., and HARRIS, R. S. Absorption and metabolism of calcium in human beings, studied with calcium-45. N.Y. Acad. Sci. Ann. 64: 314-325. 1956.

"Metabolism expts. with Ca^{45} were performed in 11 16-year-old boys and in 2 adults, 21 and 22 years old. Blood disappearance curves and retention values indicated a lower rate of bone formation in the adult. Ca absorption decreased as the intake increased, but appeared to have little or no relation to age. Endogenous Ca was shown to be excreted to an appreciable degree in the feces; in 7 subjects 5-15% of fecal Ca was endogenous in origin. The

authors suggest that bone-salt formation and resorption are rate-limiting processes in Ca metabolism." (Chem. Abs. 51: 9826.)

111. CURTIS, H. J. The effect of clay on the intestinal absorption of strontium. U.S. Atomic Energy Comm. MDDC-419, 8 p. 1946.

"Rats were fed active strontium that was adsorbed on clay, and their controls were fed the same amount of active strontium in aqueous solution. There was no significant difference in the amount deposited in the skeleton between the two groups, and it is concluded that if ions are adsorbed on inert material, they will be eluted during their passage through the gastrointestinal tract." (Authors' abstract.)

112. FOURNIER, P. The absorption of calcium in the adult rat. III. Influence of the initial state of the animal. Acad. des Sci. Paris, Compt. Rend. 236: 2537-2539. 1953.

"After ingestion for several days of a diet almost deprived of Ca, adult rats were given a diet containing 0.48 percent Ca, which initially greatly enhanced the absorption of quantities of Ca, then diminished regularly to a minimum after a week. The following experiments show that from the beginning the animal absorbs only a small amount of Ca. Adult male rats 7 months old were put into two lots, I and II. At the beginning of the experiment each animal received 16 g. per day of a diet containing 0.01 percent Ca (purified casein, purified starch, peanut oil, salt mixture, vitamins). This diet was given for 2 days to lot I and for 3 weeks to lot II. A second diet (0.41 percent Ca) differing from the preceding by the introduction of 1 percent of CaCO_3 and 1 percent of TiO_2 in place of the starch was then tried. The feces of 24 hours was recovered and analyzed. The presence of TiO_2 , an inert and unabsorbable substance, makes it possible to calculate the coefficient of absorption of Ca by:

$$\frac{(\text{Ca}/\text{TiO}_2) \text{ diet} - (\text{Ca}/\text{TiO}_2) \text{ feces}}{(\text{Ca}/\text{TiO}_2) \text{ diet}} \times 100$$

The product of this coefficient and the quantity of ingested Ca gives the quantity of absorbed Ca. The rats in lot I absorbed only small quantities of Ca (7 mg./day) immediately after the ingestion of the diet rich in Ca, whereas the rats in lot II absorbed a large quantity of Ca the first day (36 mg.), which decreased gradually to the same value as the rats in lot I by the end of the seventh day. At 7 months the rats had not completely finished their growth and retained about 5 mg. of Ca per day. In lot II this retention could not be measured." (Author's abstract.)

113. GLIDDEN, M. A., MORRISON, R. I., and MOSCHETTE, D. S. Metabolic studies with pre-adolescent girls. IV. Utilization of calcium. Amer. Dietet. Assoc. Jour. 32: 29-35. 1956.

"Ca intake, excretion, and retention were detd. for 6 subjects who lived on a controlled dietary regimen. The daily mean intake of Ca was 0.85 g. The source of Ca was Ca lactate or nonfat dry-milk solids. On this level of Ca intake 5 of the 6 subjects were in neg. balance. The Ca retention of all the subjects appeared to increase when nonfat dry-milk solids were added to the diet." (Chem. Abs. 50: 5863.)

114. HAMILTON, J. G. Metabolism of fission products. Progress report for period ending April 15. U.S. Atomic Energy Comm. MDDC-1001, 27 p. 1944.

Preparation of carrier-free Zr^{83} ; metabolism of carrier-free Zr^{83} and Y^{83} after intramuscular, intrapulmonary, and oral administration; distribution of carrier-free Ce^{140} after intramuscular and intrapulmonary administration; decontamination studies with products of nuclear fission; factors affecting absorption of orally administered radiostrontium; excretion of injected radiostrontium, radioyttrium, and radiocerium.

115. HAMILTON, J. G. Metabolism of radioactive elements created by nuclear fission. New England Jour. Med. 240: 863-870. 1949.

Data are presented on the oral absorption, principal organ of retention, and accumulation in and rate of elimination from the organ of Pu^{239} , Np^{239} , and the long-lived fission products.

116. HANSARD, S. L., COMAR, C. L., and PLUMLEE, M. P. Absorption and tissue distribution of radiocalcium in cattle. Jour. Anim. Sci. 11: 524-535. 1952.

"The radio-Ca soln. was administered to cattle as a single dose, either orally or intravenously, and concurrent 7-day chem. and radioisotope balance studies were started. Chem. analyses were used to calc. the amts. of Ca and P ingested. The fecal excretion of Ca was $85 \pm 17\%$ of the dietary intake, the fecal excretion of orally administered radio-Ca being $66 \pm 9\%$. About 15% of intravenously administered radio-Ca was excreted in the feces and 0.3% in the urine." (Chem. Abs. 49: 7675.)

117. HANSARD, S. L., and CROWDER, H. M. Physiological behavior of calcium in the rat. Jour. Nutr. 62: 325-339. 1957.

"Ca absorption, retention, and excretion rate were greatest in young animals, decreased rapidly to the age of sexual maturity, and more slowly to maturity and old age. Daily endogenous fecal Ca losses and the requirements for maintenance increased slightly to maturity and markedly in the aged animal. Tissue deposition reflected the physiol. status of the animal and its ability to handle the current Ca supply. The significance of fecal Ca partition, the estn. of endogenous Ca, true digestibility, maintenance requirements, and the interpretation of Ca^{45} data in terms of the behavior of stable Ca in the animal body are discussed." (Chem. Abs. 51: 18188.)

118. HARRISON, H. E., and HARRISON, H. C. Studies with radiocalcium: The intestinal absorption of calcium. Jour. Biol. Chem. 188: 83-90. 1951.

"The rate of absorption of Ca administered as CaCl_2 soln. contg. Ca^{45} was determined in rachitic, vitamin D-treated, and control rats. The most rapid rate of absorption occurred within 2-4 hrs. of administration and was from the proximal portion of the small intestine. The amt. absorbed was not influenced by vitamin D. Analyses of the contents of sep. portions of the small intestine showed that after 4 hrs. little radio-Ca remained in the proximal 2/3 of the small intestine, and that the major portion of the unabsorbed radio-Ca was found in the distal 1/3 of the small intestine and in the large intestine. Absorption of Ca from the distal portion of the intestine was found in rats receiving vitamin D but not in untreated rachitic rats, except in animals in which the intestinal tract had previously been emptied of Ca by feeding a Ca-free diet. Vitamin D may be effective in the absorption of Ca only under conditions in which the Ca of the intestinal contents is poorly sol. Ca can be absorbed from the distal intestine. Under comparable conditions, less Ca was absorbed by rats 10-20 weeks old than by rats 6-8 weeks old." (Chem. Abs. 45: 4319.)

119. HEGSTED, D. M. Calcium requirements. Nutr. Rev. 15: 257-258. 1957.

120. HIGHTOWER, B. M., and WILLIAMS, E. F., JR. Meat feeding and absorption of labeled calcium. Fed. Proc. 11: 230. 1952.

"Each of nine young albino rats was maintained on a diet of 16 g. of lean meat per day for 5 days. At the end of the third day each rat received by stomach tube a solution of 5 mg. of radioactively labeled calcium as chloride. Seven control rats were maintained on a diet of glucose and CellufLOUR for the same period of time. At the end of the third day each of these rats also received by stomach tube 5 mg. of labeled calcium as chloride. Urine and feces were collected for 48 hours, after which the rats were sacrificed and the gastrointestinal tract,

the remaining carcass, and blood samples were taken for analysis. It was found that the rats which were maintained on the control diet absorbed an average of 68 percent of the administered dose of calcium, whereas the rats that received the meat diet absorbed an average of 46 percent. The recovered nonabsorbed fraction amounted to 33 percent for the control group and 48 percent for the group receiving the meat diet." (Author's abstract.)

121. JONES, H. G. Some factors influencing the gastrointestinal absorption of strontium in rats. *Atomic Energy Res. Etab. (Gt. Brit.) SPAR 6*, 3 p. 1955.

"Three-month-old rats (male) under light anesthesia were fed by stomach tube. Soft tissue took up little Sr so the skeleton was dissected free and dry ashed. Tissue and feces were also dried and dry ashed. All residues were taken up in 6N HNO₃. The mean recovery of activity in 100 animals was 94.1%. Fasting for 24 hrs. before and after isotope feeding doubled retention of Sr in skeleton after 1 and 3 days; fasting up to 24 hrs. had no effect. Comparison of femora and tibiae samples showed less than 10% error due to sampling. Feeding carrier Sr with the Sr⁹⁰ increased urinary activity but did not affect skeleton retention of activity. Massive doses of carrier increased absorption from the gut to such an extent that skeleton retention doubled in spite of greatly increased urinary excretion. There was no significant effect on absorption by Na₂SO₄, CaSO₄, Fe₂O₃, Versene, or Ca phytate. After parenteral injection of carrier-free Sr⁹⁰, 12% is excreted via the gut." (Chem. Abs. 50: 9609.)

122. JONES, H. G., and COID, C. R. The passage of strontium across the intestinal wall of the rat. *Clin. Sci.* 15: 541-549. 1956.

"It has been shown by direct injection into the lumen of various parts of the alimentary canal that Sr⁹⁰, which is administered orally, is absorbed mainly from the first half of the small intestine. After its intravenous injection Sr⁹⁰ passes into the lumen of all parts of the alimentary canal but mainly into the first half of the small intestine. The rate of transfer of Sr⁹⁰ from the blood to the lumen of the small intestine has been shown to be directly proportional to the concentration of Sr⁹⁰ in the blood, i.e., the intestinal clearance is constant. The initial transfer after intravenous injection of Sr⁹⁰, when the blood level is still high, is very rapid, amounting to 0.5% of the injected dose in 10 minutes. Sr⁹⁰ has been shown to move in both directions between the lumen of the intestine and the blood, reaching equilibrium at a certain blood concentration. The significance of this is discussed." (Author's summary.)

123. KIKUCHI, T., and others. The metabolism of fission products. I. The metabolism of the radioactive ashes obtained from the No. 5 Fukuryu Maru. *Kyoto Univ. Inst. Chem. Res. Bul.*, sup. issue, Nov. 1954, p. 75-83. 1954.

G. Wakisaka, T. Kono, H. Goto, H. Akagi, T. Yamamasu, and I. Sugawa, joint authors.

"When the radioactive ashes were administered by mouth, the radioisotopes which were chiefly absorbed were alk. earths, and were deposited mainly in the bones. When, after the removal of the alk. earths, the radioisotopes contained in the radioactive ashes were administered by mouth in the form of chloride or citrate, the radioisotopes chiefly absorbed were heavy metals such as Ru and Rh." (Chem. Abs. 49: 5138.)

124. KIKUCHI, T., and others. The metabolism of fission products. II. The metabolism of the radioisotopes contained in the radioactive ashes obtained from the No. 5 Fukuryu Maru. *Kyoto Univ. Inst. Chem. Res. Bul.*, sup. issue, Nov. 1954, p. 84-98. 1954.

G. Wakisaka, T. Kono, H. Goto, H. Akagi, T. Yamamasu, and I. Sugawa, joint authors.

"Among the radioisotopes obtained by sepn. from ashes on the ship, i.e., Y⁹¹, C¹⁴¹, Pr¹⁴⁴, Ca⁴⁵, Sr⁹⁰, Ru¹⁰³, Rh¹⁰⁶, Zr⁹⁵, Nb⁹⁵, and I¹³¹, Sr, Ca, and Y were accumulated

chiefly in the bones of adult mice, and the elimination of radio-Sr from there was very slow. When administered by mouth, radio-Sr and radio-Ca were readily absorbed from the digestive tract while the absorption of radio-Y was poor." (Chem. Abs. 49: 5138.)

125. KIRPICHNIKOV, V. S., SVETOVIDOV, A. N., and TROSHIN, A. S. Labelling of carp with radioisotopes of phosphorus and calcium. *Akad. Nauk S.S.S.R. Dok.* 111: 221-224. 1956.

"Young carp were placed in a vessel with 1-2 mc./l. level of radioisotopes (Ca⁴⁵ and P³²) for 2 hrs. The rate of uptake of P in descending order of the fish organs was: gills, fins, heart, liver, bladder, vertebrae and muscle. The decline of activity after the fish had been placed in plain water is shown graphically, showing prolonged retention in the bones and scales, being most rapidly lost from heart, liver, and muscle. Ca⁴⁵ is retained in descending order by the various tissues as follows: gills, internal organs, scales, fins, gill covers, vertebrae, and muscle. The loss of radioactivity after removal from the exptl. tank was slowest in the bone, and most rapid in soft tissues. The results indicate the possibility of absorption of radioisotopes by carp fish directly from the medium. The Ca⁴⁵ label can be used for fish tracing for 1-1.5 years." (Chem. Abs. 51: 7595.)

126. LENGEMANN, F. W., COMAR, C. L., and WASSERMAN, R. H. Absorption of calcium and strontium from milk and nonmilk diets. *Jour. Nutr.* 61: 571-583. 1957.

"The availability of Ca from milk was contrasted with that from CaCl₂ in rats, rabbits, and human subjects, and with Ca supplied with grain in cattle, rats, and rabbits. In cattle, the retention of single oral doses of Ca⁴⁵ and Sr⁹⁰ gave essentially the same results as the conventional detn. of Ca balance. Calves on a milk diet absorbed and retained a very high percentage of the Ca present. Similar animals on a hay diet and grain diet showed a much lower absorption and retention. A calf on hay and grain for 30 days showed the typical high-Ca utilization when returned to a milk diet. The Ca retention of an 11-year-old cow was improved by the addn. of dried skim milk in the ration. Young and old rats absorbed about 1½ times as much Ca⁴⁵ from milk as from a soln. of CaCl₂ or from CaCl₂+grain. Young and old rabbits showed no increased Ca⁴⁵ absorption from milk. Three out of 4 human subjects absorbed an av. of 34% ingested Sr⁹⁰ from CaCl₂ as compared with 82% from milk." (Chem. Abs. 5: 13100.)

127. LICHTWITZ, A., and CLEMENT, D. Calcium metabolism: Intake, elimination, balance, distribution of calcium and phosphorus. *Semaine Hôp.* 30: 2866-2878. 1954.

"A review." (Chem. Abs. 49: 1915.)

128. LICHTWITZ, A., PARLIER, R., and CLEMENT, D. Phosphorus metabolism and its relation to calcium metabolism. *Rev. Rhumatisme* 24: 163-173. 1957.

129. LOVELACE, F. E., and PODOLIAK, H. A. Absorption of radioactive calcium by brook trout. *Prog. Fish Cult.* 14: 154-158. 1952.

"Small non-feeding brook trout absorb Ca from the water in which they live. By the use of radioactive Ca, measurements indicated that entrance to the body is through the gills. After entering the body, the Ca is quickly distributed to organs, muscles and skeleton." (Chem. Abs. 47: 11575.)

130. MacDONALD, N. S., and others. Gastrointestinal absorption of ions. I. Agents diminishing absorption of strontium. *Jour. Pharmacol. and Expt. Ther.* 104: 348-353. 1952.

R. E. Nusbaum, F. Ezmirlian, R. C. Barbera, G. V. Alexander, P. Spain, and D. E. Rounds, joint authors.

"Thirty-two substances readily available in large quantities were screened for ability to diminish skeletal

deposition of ingested Sr. SrCl_2 soln. was given to fasted rats by stomach tube and followed immediately by an aq. soln. or suspension of the substance. After 24 hrs., Sr in the femurs was detd. spectrographically. Substances decreasing skeletal deposition of Sr are, in decreasing order of efficacy: MgSO_4 , Na_2SO_4 , the NH_4 salt of an amido polyphosphate (Victamide), 2 carboxylic type cation-exchange resins, a colloidal phosphorylated glucoside, Ca phytate, pectin, a prepd. bran cereal, castor oil, and a hydrophilic gum from plantago seed. The following had little or no influence: bentonite, kaolin, hydrated alumina, sol. starch, methylcellulose, carboxymethylcellulose, agar, gum acacia, crude lignified cellulose, gelatin, fresh egg white, oatmeal, phenolphthalein, mineral oil, and the disodium salt of ethylenediaminetetraacetic acid. Powd. milk, tannic acid, inulin, Na alginate, and a carboxylic and sulfuric acid-substituted starch (Nu-film) all increased skeletal accumulation of ingested Sr." (Chem. Abs. 46: 6762.)

131. McHARDY, G. J. R., and PARSONS, D. S. The absorption of inorganic phosphate from the small intestine of the rat. *Quart. Jour. Expt. Physiol.* 41: 398-409. 1956.

"The net absorption of inorg. phosphate (I) was measured in the jejunum and ileum of male albino rats. The rate increased with decreasing H-ion concn. by 80% when the pH was raised from 4.4 to 7.9. There was no optimal value for absorption in this range. Increasing the concn. of I in the intestinal lumen increased the net absorption of rate linearly. The rate was relatively uninfluenced by the tonicity of the intestinal contents, but was greatly diminished in the presence of low concns. of Na. The presence of 37 mM of glucose in the intestinal contents had no effect on the net absorption of I. I was absorbed more rapidly from the jejunum than from the ileum. This difference in rate may be accounted for by the difference in mucosal area between the two regions." (Chem. Abs. 51: 5945.)

132. MAROLDA, C. I., and AZORÍN, E. Blood calcium in rabbits after rectal administration of calcium gluconate. III. *Semana Méd. [Buenos Aires]* 11: 37-38. 1955.

"Presentation of calcs. to show that the differences obtained are not significant." (Chem. Abs. 49: 13426.)

133. MELLANDER, O. The physiological importance of the casein phosphopeptide calcium salts. II. Peroral calcium dosage of infants. *Acta Soc. Med. Upsaliensis* 55: 247-255. 1950.

"Balance tests on infants showed that calcium bound to phosphopeptides from cow's milk casein could be resorbed from the digestive tract. Calcium in this form could also be demonstrated to promote bone calcification in rachitic children in some cases without concurrent administration of vitamin D." (Author's summary.)

134. MELLANDER, O., and ISAKSSON, B. The physiological importance of the casein phosphopeptide calcium salts. I. Intravenous and peroral calcium dosage in animal experiments. *Acta Soc. Med. Upsaliensis* 50: 239-246. 1950.

"The experiments showed: That calcium bound to casein peptides containing phosphorus when injected intravenously into rabbits causes a rise in the blood calcium level, which very rapidly (within 30 minutes) returns to normal in young animals. In fully grown animals the blood calcium values seem to return more slowly to their original level. That peptide calcium given intravenously does not yield any material increase of calcium secretion in the urine during the 2 hours immediately following the injection. That no very material part of the intravenously injected peptide calcium is secreted in the urine and feces. That the retention of the peptide calcium can be estimated at 50 to 70 percent at the lowest under the experimental conditions adopted. That peptide-bound calcium given by mouth to rats on rachitogenic diets counteracts the development of rickets and is deposited in the bones." (Author's summary.)

135. MOORE, J. H., and TYLER, C. Intestinal absorption and excretion of calcium and phosphorus in the pig. I. A critical study of the Bergeim technique for investigating the intestinal absorption and excretion of calcium and phosphorus. *Brit. Jour. Nutr.* 9: 63-80. 1955.

"In pigs slaughtered 2, 4 and 6 hours after feeding it was noted that the pH of stomach contents became more acid with increased time after feeding. During early stages of digestion, removal of Ca and P from the stomach of the pigs was more rapid than removal of insoluble ash. Preferential removal of Ca from the stomach seemed to cease during the 4-6 hour period post-feeding. Solubility of Ca and P in contents of the small intestine was greatest in the upper sections, and it is considered that most absorption of Ca and P takes place from these sections. Evidence was not obtained that Ca and P are excreted through the wall of the large intestine of the pig. A diurnal variation in fecal excretion of Ca and P was noted, the higher concentration occurring in the morning excretions, and the lower in the afternoon and evening." (Biol. Abs. 30: 16098.)

136. MOORE, J. H., and TYLER, C. Studies on the intestinal absorption and excretion of calcium and phosphorus in the pig. II. The intestinal absorption and excretion of radioactive calcium and phosphorus. *Brit. Jour. Nutr.* 9: 81-93. 1955.

"Pigs 9-10 weeks of age were fed diets containing 2% calcium phosphate prepared from Ca^{45} and P^{32} . Slaughter at measured intervals after feeding showed that both Ca and P may be secreted into the upper part of the small intestine and reabsorbed to a certain extent into the lower part of the small intestine. Neither Ca nor P appeared to be secreted through the wall of the large intestine. Pigs fed CaCO_3 showed lower P solubility in the gastrointestinal contents than those fed calcium phosphate. Solubility of both Ca and P in the cecal contents was higher, and pH of the cecal contents was lower where calcium phosphate, rather than carbonate, was fed. Moreover, after inclusion of calcium phosphate as 2% of the diet, hydrolysis of phytate P occurred both in the stomach and large intestine." (Biol. Abs. 30: 16099.)

137. MOORE, J. H., and TYLER, C. Intestinal absorption and excretion of calcium and phosphorus in the pig. III. Effect of beryllium carbonate on absorption of phosphorus. *Brit. Jour. Nutr.* 9: 389-397. 1955.

"Beryllium carbonate was added to the diet of 2 pigs at a level of 2.4% for 10 days. The pigs were slaughtered 4 hrs. after feeding on the 11th day, and the pH, total Ca and P, solubility of Ca and P, and phytate P were determined in the gastrointestinal tracts, and in 2 controls. Absorption of P from the intestine was reduced by beryllium carbonate, mainly because of decreased hydrolysis of phytate. Beryllium carbonate also appeared to act as a cereal phytase inhibitor, and beryllium phytate compounds are precipitated. Ca absorption was also decreased probably as a result of reduced phytase hydrolysis." (Internatl. Abs. Biol. Sci. 4: 3518 III.)

138. THOMAS, R. O., LITOVITZ, T. A., and GESCHICKTER, C. F. Alterations in dynamics of calcium metabolism by intraintestinal calcium reservoirs. *Amer. Jour. Physiol.* 176: 381-387. 1954.

"In rabbits the continuous oral ingestion of spinach either for 7 or 13 days increases the blood disappearance rate of Ca and increases the fecal excretion rate as measured by Ca^{45} . After the spinach diet the bone uptake of Ca^{45} is correspondingly depressed for a period of 5 days and the urinary excretion for the next 3 days. In a similar manner the blood disappearance rates of Ca^{45} and the fecal rate of Ca excretion can be increased by administering by stomach tube 1250-3750 mg. of Na Versene or by administering 20 g. of CaHPO_4 . When Ca^{45} as CaCl_2 is injected directly into the duodenum through an abdominal incision the Ca level in the blood reaches its peak in about 20 min. Thereafter the disappearance rates in the blood are similar to that for intravenously injected Ca^{45} . However, the blood values remain higher after intestinal

absorption since the max. concn. in the blood reached by intravenous injection is never achieved by the intestinal route." (Chem. Abs. 48: 6545.)

139. THORNTON, P. A., SCHAIBLE, P. J., and WOLTERINK, L. F. Intestinal transit and skeletal retention of radioactive strontium-90-yttrium-90 in the chick. *Poultry Sci.* 35: 1055-1060. 1956.

"Following injection into the crop, about $\frac{1}{3}$ of the isotope left the upper portion of the digestive tract in 7.5 min. Movement of the remaining isotope occurred at a simple exponential rate highly correlated with time. Deposition in the skeleton was highly correlated with the amt. passed to the absorptive part of the intestines." (Chem. Abs. 51: 14038.)

140. TOMIYAMA, T., ISHIO, S., and KOBAYSHI, K. Absorption of Sr^{90} by carp. In *Research in the effects and influences of the nuclear bomb test explosions*, compiled by the Committee for Compilation of Report on Research in the Effects of Radioactivity, v. 1, p. 1181-1187. Tokyo, Japan Society for the Promotion of Science, 1956.

141. WASSERMAN, R. H., COMAR, C. L., and NOLD, M. M. The influence of amino acids and other organic compounds on the gastrointestinal absorption of calcium-45 and strontium-89 in the rat. *Jour. Nutr.* 59: 371-383. 1956.

"Eighteen amino acids, including those essential for the rat, were assayed for effect on the gastrointestinal absorption of Ca^{45} and Sr^{89} . The minerals and amino acids were ingested simultaneously; radioassay values for the femur obtained 24 hrs. after dosage were used as a measure of absorption. Certain of these amino acids, notably lysine and arginine, promoted the absorption of Ca^{45} and Sr^{89} . The rat preferentially absorbed Ca^{45} over Sr^{89} by a factor of about 1.7. A dose response curve of lysine vs. femur Ca^{45} and Sr^{89} values showed that a molar ratio of lysine: CaCl_2 between 1 and 2 was necessary for significant increases in mineral absorption. Lactose produced a greater response than L-lysine and L-arginine. The latter 2 were more effective in promoting mineral absorption than gluconate, lactate, citrate, or a mixt. of the B vitamins. These findings are discussed in terms of possible mechanism of action for the stimulatory amino acids." (Chem. Abs. 50:17025.)

142. WOLTERINK, L. F., and COLE, L. L. Rate of absorption of radioactive calcium and strontium from the intestine. *Fed. Proc.* 13: 166-167. 1954.

"Absorption rates computed solely from the disappearance of materials introduced into the intestine will be too low if secretion back into the bowel occurs, as with calcium or strontium. Analysis of the time curve for the appearance and disappearance of the radioactive tracers in the blood gives considerably higher rates for intestine to blood transport. The difference between the rate computed from blood and the rate computed from gut recovery is the rate of secretion into the bowel. The rate of transport back into the bowel of both calcium and strontium is about two-thirds of the initial rate of absorption from the bowel. No constant difference between calcium and strontium was observed. The rates are independent of the time of transit through the intestine. Consequently, differences in the amount of tracer deposited in the skeleton are not due to differences in the true intestinal absorption rate but depend on the size of the pool available for absorption and the time the pool is available. Administration of a high level of thyroxine increases the rate of passage of food through the bowel. Consequently, considerable tracer, which might otherwise be absorbed, is lost by defecation." (Author's abstract.)

AVAILABILITY OF CALCIUM FROM DIETARY SOURCES

143. BROCHART, M. Study of the calcium and phosphorus requirements of dairy cattle by estimating

calcium and phosphorus in the hair. *Ann. de Zootech.* 6: 151-179. 1957.

"The methods of estimating Ca and P in hair, blood and bone are described. Preliminary investigations showed that Ca content was different in the base and the tip of the same hair, that it differed among samples from different parts of an area, e.g., the top of the head, and was different in hairs of different colours. The P content showed little such variation. For the main study 2 Black Pied Dutch heifers were used. They were studied for 2½ years, during which maintenance standards differed between them, producing marked differences in blood Ca and P. Blood was analyzed periodically, and also hair from the shoulder, an area which moults seasonally, and from the head. Between these areas there was no similarity in the pattern of change of Ca and P contents. The pattern in hair from the head followed that of changes in the blood, with a time lag of from 1 to 3 months, the shorter when hair was cut frequently and so was growing more rapidly. The data indicated a straight line relation between the Ca and P contents of blood and hair of the head. The Ca of hair was mainly concentrated in the outer part of the hair; this explained the higher content in black hairs, with little medulla, than in white hairs. The proportion of medulla, high at the base of the hair, compared with the tip, also explained the higher Ca content of the tip. Ca was probably an important structural component of the keratin, and was obtained directly from the blood. P was mostly present in the hair as phospholipin, and was probably related to phospholipins of sebum, for which serum inorganic P supplied the P." (Nutr. Abs. and Rev. 28: 3053.)

144. CAUSERET, J., and HUGOT, D. Comparative efficiency of calcium carbonate and tricalcium phosphate as a function of the amount of calcium in the regular diet. *Acad. des Sci. Paris, Compt. Rend.* 245: 1169-1171. 1957.

"White male rats weighing 75-90 g. were used to study the effects of alimentary intake of various amts. of CaCO_3 , $\text{Ca}_3(\text{PO}_4)_2$, and $\text{CaCO}_3 + \text{Ca}_3(\text{PO}_4)_2$ on the Ca:P ratio, Ca retention, and coeff. of retention. Increasing the amt. of Ca intake increased the Ca:P ratio from approx. 0.26 on a 0.10% dietary level of Ca to 1.94 when CaCO_3 was used and 0.97 when $\text{Ca}_3(\text{PO}_4)_2$, or $\text{CaCO}_3 + \text{Ca}_3(\text{PO}_4)_2$ was fed. The coeff. of Ca retention decreased as the amt. of Ca in the diet increased." (Chem. Abs. 52: 4760.)

145. FISCHER, E., and AZORÍN, E. Influence of rectal calcium application upon the serum calcium level of rabbits. *Arzneimittel-Forsch.* 4: 501-503. 1954.

"Ca gluconate (I) was given in the form of rectal suppositories to rabbits on a standard diet and the blood level of Ca detd. A dose of 0.009 g./kg. I causes a significant increase in the Ca level, and 60% of the applied Ca appears in the blood. The increase begins 2 hrs. after application and lasts to 8 hrs. Increase of I above the amt. of 0.009 g./kg. causes no further rise in the blood but prolongs this action; a dose of 0.0045 g./kg. causes no significant increase of the Ca level." (Chem. Abs. 9: 518.)

146. GROSS, W. J., and others. The availability of radiostrontium to mammals by way of the food chain. *U.S. Atomic Energy Comm. UCLA-259*, 26 p. 1953.

J. F. Taylor, J. A. Lee, and J. C. Watson, joint authors. " Sr^{90} is selectively metabolized by rats when ingested in the form of barley or lettuce grown on $\text{Sr}^{90} + \text{Y}^{90}$ contaminated soil. Aggregation occurs in the tissues (mainly skeletal) when such doses are administered at the rate of 500 to 1000 dis/sec/day. Deposition from contaminated plant material is less than from equal doses of $\text{Sr}^{90} + \text{Y}^{90}$ in aqueous solution. The rate of deposition of Sr^{90} from equal daily oral doses of $\text{Sr}^{90} + \text{Y}^{90}$ decreases with time during a prolonged feeding experiment. Thus young rats fed daily $\text{Sr}^{90} + \text{Y}^{90}$ in solution over a seven-day period retained 7.9% total dose while young rats given daily doses of $\text{Sr}^{90} + \text{Y}^{90}$ over a seventeen-week period retained only 1.8% total dose. The amount of Sr^{90} deposited from oral doses is influenced little, if any, by the amount of stable Sr in the diet at the time of the Sr^{90} ingestion.

Stable Sr, however, apparently effects the release of deposited Sr^{90} from the tissues when it is administered orally in massive doses ten days following the ingestion of Sr^{90} . This suggests stable Sr as a therapeutic agent. No radiation effects are identified in any of the experimental animals even in the extreme case where rats were given daily doses of $\text{Sr}^{90} + \text{Y}^{90}$ of 2733 dis/sec over a seventeen-week period. A method for predicting the maximum level of retention under a given set of conditions for any radioisotope of any physiological element is discussed. Rats fed $\text{Sr}^{90} + \text{Y}^{90}$ over a seventeen-week period with the daily dose of 2733 dis/sec for a cumulative dose of 431,000 dis/sec averaged a retention of 5976 dis/sec or sixty-six % of the calculated maximum. The observed retention after thirty daily doses of 688 dis/sec was 2293 dis/sec, also sixty-six % of the calculated maximum." (Nuclear Sci. Abs. 7: 4717.)

147. GUGLIELMI, G., BORRELLI, P. L., and ZUCCONI, C. Absorption, distribution and elimination of radioactive Ca^{45} administered intravenously, subcutaneously, rectally, orally and by aerosolization. *Gior. di Med. Mil.* 106: 288-292. 1956.

148. HANSARD, S. L., CROWDER, H. M., and LYKE, W. A. Biological availability of calcium in feeds for cattle. *Jour. Anim. Sci.* 16: 437-443. 1957.

"Results are presented of concurrent chemistry and radio-Ca balance studies which reflect the endogenous loss and permits the calcn. of Ca availability from selected sources of org. and inorg. Ca fed to young and mature cattle. Indications were that true digestibility was greater in young than in mature steers and that the difference due to age was greater than that due to Ca source." (Chem. Abs. 52: 1506.)

149. HAYAMI, H., and others. The utilization of calcium from various sources. VIII. A comparison of calcium sulfate, carbonate, and phosphate. *Natl. Inst. Nutr. Ann. Rpt. [Tokyo]* 1955: 24-26. 1955.

Y. Matsuno, K. Mori, M. Suzuki, and S. Saito, joint authors.

"Expts. with rats showed no difference in growth, Ca content of bone, and Ca utilization when Ca was fed as sulfate, carbonate, or phosphate." (Chem. Abs. 51: 16753.)

150. HUGOT, D., and CAUSERET, J. Comparative biological efficacy of calcium salts as a function of calcium supply in diet. *Acad. des Sci. Paris, Compt. Rend.* 244: 948-950. 1957.

"The physiological utilization of the Ca of 3 salts was compared for different levels of Ca in the diet. Rats weighing 55 to 75 g. were divided into lots of 6 or 7, receiving Ca as carbonate, sulphate or lactate to make the final Ca content of the diet 0.1, 0.2, 0.35, 0.5 or 0.7 per cent; the P content remained constant at 0.36 per cent. The coefficients of retention of Ca were studied in 10-day balance experiments. The physiological utilization of Ca varied considerably with the Ca content of the diet, but was almost identical for the different salts. The Ca retained in mg. daily was 7.5 to 7.9 for a Ca intake of 0.1 per cent, and increased steadily to 23 to 25 for an intake of 0.7 per cent; corresponding coefficients of retention fell from 87 or 89 to 36 or 40 per cent." (Nutr. Abs. and Rev. 27: 3765.)

151. IMADA, S., and others. Studies on the calcium in food (III). Utilization of calcium oxalate by albino rats using Ca^{45} . Osaka, Japan, Imp. Univ., Faculty Sci. Living, Rpts. Sci. Living 2 (3), Ser. D, p. 25-30. 1954.

T. Kohno, H. Kitamura, and T. Tanimoto, joint authors. "Six days after the administration of Ca^{45} oxalate mixed with calcium lactate, phosphate, or carbonate to a group of mature and of young rats, the amt. of Ca fixed in the body was 20-21% in the former and 20-44% in the latter. No differences in the fixation were observed in the mature rats by varying the nature of the nonradioactive salts added but some differences were found with young rats." (Chem. Abs. 49: 14989.)

152. KOTAKE, Y. The utilization and absorption of various calcium salts by the body. *Jap. Soc. Food and Nutr. Jour.* 4: 168-171. 1951-52.

"Calcium caseinate was superior to Ca lactate when given to young albino rats and the bone formation was compared. The existence of cottonseed oil in the diet with Ca caseinate was very desirable. When injected in rats Ca glutamate and Ca glycinecarbamate were both utilized for bone formation." (Chem. Abs. 48: 5313.)

153. LONG, T. A., and others. Availability of phosphorus in mineral supplements for beef cattle. *Jour. Anim. Sci.* 16: 444-450. 1957.

A. D. Tillman, A. B. Nelson, W. D. Gallup, and B. Davis, joint authors.

"The effects were compared of different levels of NaH_2PO_4 , a supplement in which the P was highly available, upon wt. gain, feed intake, and plasma P in beef cattle. These initial expts. established the crit. level desired for studying the response to intake and availability of P to be 0.15%. A comparison of steamed bonemeal, Curacao Island phosphate, and dicalcium phosphate indicated no difference statistically significant in these phosphates as sources of P for beef cattle." (Chem. Abs. 52: 1389.)

154. SARPENAK, A. E., KARPYSEVA, V. S., and BALASOVA, O. N. Availability of calcium and phosphorus in bonemeal. *Voprosy Pitaniya* 16: 56-61. 1957.

"The subjects, considered as healthy, were 6 patients convalescent from gastric ulcer or bronchopneumonia, and were between 18 and 40 years of age. They were on balance experiments for four 3-day periods. For the first 2 periods they received the basal diet, which was a complete mixed diet providing 0.26 g. Ca and 1.147 g. P daily, and in the last 2 periods they received a supplement of 2 g. bonemeal thrice daily mixed with food. The bonemeal was tasteless and was well accepted, and the supplement transformed negative or slightly positive balances of both Ca and P into strongly positive balances." (Nutr. Abs. and Rev. 27: 5275.)

155. SHOFIELD, F. A., and others. Utilization of calcium, phosphorus, riboflavin, and nitrogen on restricted and supplemented diets. *Jour. Nutr.* 59: 561-577. 1956.

D. E. Williams, E. Morrell, B. B. McDonald, E. Brown, and F. L. MacLeod, joint authors.

"Ca, P and riboflavin were better utilized when given in natural foods than as CaHPO_4 and synthetic riboflavin added to diets devoid of milk, eggs, and wheat. Intestinal absorption of Ca and P was poorer with the mineral source but supplementary CaHPO_4 equivalent to 1.4 g. per day gave positive balances in 17 young women. Riboflavin excretion was correlated with intake but dietary riboflavin was utilized well above the recommended requirement of 1.4 to 1.9 μg . per day. 54 g. protein daily achieved N equilibrium." (Internatl. Abs. Biol. Sci. 6: 664.)

156. SPROWLS, R. G., JONES, I. R., and HAAG, J. R. The calcium-phosphorus requirements of dairy cattle. *Amer. Dairy Sci. Assoc. 37th Ann. Meeting West. Div. Proc.* 1956: 1-13. 1956.

"Dairy cows fed a low-P ration voluntarily consumed 3 times as much Na_2HPO_4 as they did bonemeal. Appetite, rather than nutritional need, seems to have detd. the individual level of salt consumption. On a ration deficient in P certain cows did not voluntarily consume sufficient mineral supplement to satisfy their P requirements as detd. by National Research Council-recommended allowances. Depraved appetite and anorexia were not observed during this investigation. Under the conditions of this investigation, blood inorg. P values were uniformly of a low order (5.2 mg./100 ml. of blood plasma is normal for mature dairy cattle.) There were wide variations below normal for which no explanation was apparent. There was no apparent relation between the blood inorg. P levels, the P requirement, and P intake. The use of blood P levels for the diagnosis of P deficiency has some

limitations due to the great variability which may be demonstrated on normal rations as well as with certain management procedures." (Chem. Abs. 51: 8225.)

157. WISE, M. B. Investigations on phosphorus metabolism: 1. Phosphorus requirement of calves. 2. Availability of the phosphorus in various sources for calves. Univ. Microfilms Pub. 23152, 207 p. 1957.

158. YOSHIMOTO, S., TSUJIMURA, Y., and HORIGUCHI, K. Serum calcium levels after the administration of some calcium salts. Eiyô to Shokuryô 9: 119-122. 1956.

"Expts. with rabbits (in a few cases also with a man or a dog) showed that intravenous or oral administration of CaCl_2 or CaCO_3 was effective in raising the serum Ca level in 0.5-1 hr. after administration (but this effect did not last further). Ca phosphate (Pearl Calc) showed this effect lasting for 8 hrs. Ca succinate, Ca citrate, and Ca glutamate showed no remarkable effect on serum Ca level." (Chem. Abs. 51: 11567.)

DISTRIBUTION AND MOVEMENT OF STRONTIUM AND CALCIUM IN THE ANIMAL BODY

159. ASANO, M., ITO, M., and KUMAGAI, T. Comparative biochemical studies on aquatic animals. I. Calcium turnover of fresh-water fish and shellfish. Tôhoku Jour. Agr. Res. 6: 341-360. 1956.

"The Ca turnover of *Carassius auratus* (I) and *Anodonta lauta* (II) was investigated. In I the fins, bones, and operculum conc. the Ca, while in II the Ca is conc. in the shell and to a lesser extent in the gill. II accumulates more Ca than I. Exhaustive decontamination of Ca^{45} from the tissues with ethylenediaminetetraacetic acid is difficult. Decontamination of living animals is more efficient than post-mortem decontamination." (Chem. Abs. 51: 5312.)

160. ASLING, C. W., and others. The localization of certain alkaline and rare earth elements in the costochondral junction of the rat. Anat. Rec. 113: 285-300. 1952.

J. G. Hamilton, D. Axelrod-Heller, and B. J. Louie, joint authors.

"Radioactive isotopes of Ca, Sr, Pm, Pu, and Am, possessing a high degree of specific activity, were administered by parenteral injection to adult rats. Following administration of these radioelements, animals were sacrificed and radioautographs prep'd. from histologic sections through the costochondral junctions. All 5 radioelements localized, in varying degrees, in both the bony and the cartilaginous segment of the rib at the end of the 1-hr. interval, though in the case of Am there is a question of its localization in the mineralized cartilaginous segment of the rib. Pm, Pu, and possibly Am, were present in the periosteal extension of the rib cartilage." (Chem. Abs. 46: 10455.)

161. BAUMAN, V. The question of calcium exchange in the chicken. Zhur. Obsheh. Biol. 17: 257-271. 1956.

"Expts. were performed on white leghorns divided into 2 groups differing only in the amts. of Ca received in their diets. After 15 days on sep. diets, all of the chickens received an injection of radio-active Ca^{45} in a CaCl_2 soln. In the first 5 days following the injection the total Ca, P, and Ca^{45} balance was studied. After that, eggs were collected to study the productivity of the chickens and to det. the concn. of Ca^{45} in the shell. Ten chickens were killed during the course of the expt. to study the Ca exchange in the internal organs, blood, and skeleton." (Chem. Abs. 51: 5939.)

162. BELANGER, L. F. The entry of calcium-45 into the skin and other soft tissues of the rat: an autoradiographic and spodographic study. Jour. Histochem. and Cytochem. 5: 56-71. 1957.

"Autoradiographic and spodographic studies on the skin, eye, cartilage, and mucous glands of the rat indicate that Ca^{45} entering the hair follicle is primarily concd. in the keratogenous zone while in the eye the outer sensory portion of the retina and ciliary body gave the strongest pos. reaction. Cartilage of the trachea and of long bones showed a relatively high reaction as compared to soft tissues with greatest intensity in regions of mineralization. Epithelial linings of the trachea and nasal cavities and the glandular epithelium of the mucous glands gave strong pos. reactions. The uptake of Ca^{45} in cartilage and mucous tissues may represent cation adsorption by the sulfopoly-saccharides." (Chem. Abs. 51: 9846.)

163. BEVELANDER, G. Calcification in mollusks. III. Intake and deposition of Ca^{45} and P^{32} in relation to shell formation. Biol. Bul. 102: 9-15. 1952.

"Fresh water and marine mollusks take up labeled Ca and P from water. Incorporation of labeled Ca was found in the periphery of the mantle and in the newly formed shell. Labeled phosphate was localized on the inner margin of the mantle in the region of the mucus glands, and also in the periostracum surrounding the crystals. The phosphatase present in the mantle appears to be connected with phosphorylating processes." (Chem. Abs. 46: 8281.)

164. BOROUGHS, H., CHIPMAN, W. A., and RICE, T. R. Laboratory experiments on the uptake, accumulation, and loss of radionuclides by marine organisms. In National Academy of Sciences, National Research Council, The effects of atomic radiation on oceanography and fisheries, Report of the Committee on Effects of Atomic Radiation on Oceanography and Fisheries, NAS-NRC Pub. 551, p. 80-87. Washington, D.C., 1957.

165. BOROUGHS, H., and REID, D. The role of the blood in the transportation of strontium 90-yttrium 90 in fish. Anat. Rec. 128: 524. 1957.

"An equilibrium mixture of $\text{Sr}^{90}\text{-Y}^{90}$ was injected directly into the heart of *Tilapia mossambica* fish. At intervals from 5 minutes to 8 days, blood was removed from the kidney sinus using one fish for each time interval. The total radioactivity was determined for whole blood, plasma, erythrocytes which were either washed or unwashed, and for erythrocyte ghosts. The radioactive decay of the blood from the 1-day fish was followed for 3 weeks until secular equilibrium reappeared. Owing to the biological fractionation of the two elements, to the difference in their radioactive decay rates, and to their different energies, it was discovered that biological experiments using $\text{Sr}^{90}\text{-Y}^{90}$ are more complex than previous investigators have apparently realized. It was possible to establish the fact that almost all the Sr-Y disappears from the blood in 1 day, and that the plasma carries almost all the radioactivity. The bulk of the yttrium originally present apparently is removed by the surface of the vascular system. A small amount is also removed from the equilibrium mixture by the red blood cells. It is suggested that the yttrium is carried on the cell surface, because the radioactive decay of the red cell "ghosts" corresponds to the radioactive decay of the yttrium 90. The fact that almost no radioactivity was detectable in the erythrocyte contents suggests that very little strontium or yttrium is bound to an interior matrix." (Author's abstract.)

166. BOROUGHS, H., TOWNSLEY, S. J., and HIATT, R. W. Metabolism of radionuclides by marine organisms. 1. The uptake, accumulation, and loss of strontium 89 by fishes. Biol. Bul. 111: 336-351. 1956.

"Sr ingested by large pelagic fishes was almost completely excreted within 24 hrs. The small amt. not excreted within this time persisted for the 27 days of the expt. The Sr was rapidly eliminated from the visceral organs and tissues. The turnover of Sr in the structural tissues (including bones, gills, integument, and muscle), however, was low. Dark muscle retained less Sr^{89} than light muscles, and bone retained less isotope than the gill arches or the cartilaginous eye ossicles. Excretion of Sr^{89} by *Tilapia mossambica* (I) was much slower than it was by

the pelagic fishes. The percentage of the dose retained by this small fish was larger, and most of the radioactivity was present in the structural tissues. Tuna injected with Sr^{90} contained about 3 times the amt. of isotope in muscle and about half as much in the gills as tuna receiving the isotope orally. From 60–70% of the dose injected into 1 muscle was retained by these fish for 14 days. I were able to conc. Sr^{90} directly from the sea water. A relatively large percentage of radioactivity was present in the viscera, and the distribution of radioactivity in the various tissues was qualitatively similar to that observed on oral administration of Sr^{90} ." (Chem. Abs. 51: 4584.)

167. BRONNER, F. Disposition of Ca^{45} injected intraperitoneally into suckling rats. Fed. Proc. 15: 224. 1956. "One hour after intraperitoneal injection of calcium chloride- Ca^{45} into 10-day-old rats, the specific activity of the serum approximated 40 percent of the dose per milligram of calcium (percent/mg.). By the 108th hour it had decreased exponentially to 0.5 percent/mg. During the same interval of time the specific activity of the calcium in muscle, in the pooled internal organs (liver, heart, lungs, gonads, spleen, kidneys, thyroid gland), and in the pelt also decreased exponentially, whereas the specific activity of the skeletal calcium increased up to the 12th hour and thereafter decreased slowly. The specific activities of the calcium in the various tissues seldom equaled that in the serum. For example, by the 8th hour after injection the specific activity of the pelt was 1.8 times that of the serum; by the 85th hour it had returned to the level of the serum specific activity. After 12 hours the specific activity of the internal organs was about five times that of the serum, and after 36 hours the specific activity of the muscle calcium was 1.5 times that of the serum. These findings are discussed in relation to the kinetics of calcium metabolism." (Author's abstract.)

168. BRONNER, F., and others. Calcium metabolism in a case of gargoylism, studied with the aid of radiocalcium. Jour. Clin. Invest. 37: 139–147. 1958.

C. E. Benda, R. S. Harris, and J. Kreplik, joint authors. "The rate of disappearance of Ca^{45} from the serum of a 10 year old patient with terminal gargoylism is described by an equation. The urinary Ca output of this patient was severely depressed, so that the urinary/fecal partition ratio of Ca^{45} was 0.24, as contrasted with a normal range of 1 to 2. The specific activities of serum and urine were alike. Fecal output of Ca and Ca^{45} was in the normal range. The endogenous fecal output of this patient was calcd. to equal 83 mg./day, or 11% of the av. total excretion of Ca in the feces. This is similar to the av. in other humans. The accretion value (A) of 0.54 g. of Ca/day was much lower than that calcd. for normal boys. The exchangeable fraction of body Ca (E) was 0.93% of the estd. body Ca content of 300 g. which is normal. Data on the level of tracer in the soft tissue (brain, liver, gastrointestinal tract) obtained at necropsy 16 days after the start of the study was consistent with similar data on animals. The level of Ca^{45} in the mineralized tissues varied inversely with the level of Ca in bone and tooth samples. This indicates that the labeling of calcified tissues corresponded to the rate of Ca deposition. 42 references." (Chem. Abs. 52: S344.)

169. BRONNER, F., and others. Studies in calcium metabolism. The fate of intravenously injected radiocalcium in human beings. Jour. Clin. Invest. 35: 78–88. 1956.

R. S. Harris, C. J. Maletskos, and C. Benda, joint authors.

"The fate of intravenously injected radio Ca (Ca^{45}) was studied in 9 boys and 1 young adult, all mentally inadequate. The rate at which the injected Ca^{45} disappeared from the blood was detd. Observations made over a period of 5 days together with assumed zero-time values were expressed by the equation: $C_t = 0.335e^{-0.281t} + 0.205e^{-0.075t} + 0.0234e^{-0.004t} + 0.0205e^{-0.0005t}$; where C_t = specific activity of the serum (% dose/mg. of Ca) and t = time (min.). This equation yielded a disappearance

rate for the serum Ca of approx. 19%/min. The av. quantity of injected Ca^{45} excreted in the urine and feces did not exceed 8% by the end of 5 days. The young adult excreted a total of 20% during this period, and by the end of 60 days he had excreted approx. 40% of the injected dose. In all individuals the urine constituted the most important route of Ca^{45} elimination, and on the av. contained 1.5–2 times the amt. of Ca excreted in the feces. Only a minor fraction of the Ca absorbed on any one day is reexcreted promptly, and the major portion is retained for some time. The "biol. half-life" of Ca^{45} in 1 young adult was approx. 260 days during the 18 to 59 days following injection of the isotope. Because injected Ca was recovered in the feces it would appear that the feces serve as one route for the elimination of endogenous Ca. Data obtained on the 1 young adult over a period of 2 months indicate that approx. 15% of his av. daily fecal output of 1.2 g. of Ca is endogenous in origin. 29 references." (Chem. Abs. 50: 6627.)

170. COHN, S. H., and others. Uptake, distribution, and retention of fission products in tissues of mice exposed to a simulant of fallout from a nuclear detonation. U.S. Nav. Radiol. Defense Lab. Proj. NM-006-015.04, 25 p. 1955.

W. B. Lane, J. K. Gong, J. C. Sherwin, R. K. Fuller, L. L. Wiltshire, and W. L. Milne, joint authors.

171. COMEL, M. Is strontium fixed in the tissues? Accad. Lincei Atti 11: 321–324. 1930.

Animals treated with Sr either by mouth or intramuscularly became deficient in lime and phosphate. In order to determine whether Sr is fixed in any tissue, fowl and rats were injected with 0.081 or 0.162 g. of Sr a day for a month. No trace of Sr was found.

172. DREISBACH, R. H. Accumulation of calcium 45 by salivary glands. Soc. Expt. Biol. and Med. Proc. 96: 555–558. 1957.

" Ca^{45} accumulation and loss in the submaxillary gland are much slower than in the kidney. Equilibrium between the gland and blood is reached approximately 4 hours after administration, whereas at 8 hours the specific activity of calcium in the blood and kidneys falls to less than one-half that in the submaxillary gland. Equilibrium is again reached at 18 hours. In female Long-Evans rats, total calcium in the submaxillary gland was 21.6 ± 1.0 meq./kg., in kidney 4.0 ± 0.1 meq./kg., and in blood 3.66 ± 0.14 meq./kg." (Author's summary.)

173. DURBIN, P. W., and others. Metabolic studies with strontium-90 in the rhesus monkey. U.S. Atomic Energy Comm. UCRL-3634, 26 p. 1957.

M. W. Parrott, M. H. Williams, M. E. Johnston, C. W. Asling, and J. G. Hamilton, joint authors.

"Adult rhesus monkeys eliminated 56% of intravenously administered Sr^{90} in the urine in 10 days, compared with 28% of Ca^{45} . The av. half-time for skeletal retention of Sr^{90} in the adult male was 470 days, for the female (with 3 closely spaced pregnancies) 315 days, and for the infant about 6 months. The concn. in the milk was 2 to 4 times the level in the plasma of the nursing female. The infant retained 18% of chronically administered (oral) Sr^{90} , the adult 5%. The metabolism of Sr^{90} in the monkey was similar to that reported in other species." (Chem. Abs. 51: 11579.)

174. FAY, M., ANDERSON, M. A., and BEHRMANN, V. G. The biochemistry of strontium. Jour. Biol. Chem. 144: 383–392. 1942.

"Adult female dogs kept at const. wt. were fed 20–192 mg. of Sr (as lactate) per kg. Several days after ingestion there is usually a fall in serum Ca, without relation to the max. level of serum Sr. Inorg. P in serum increases independently of the Sr and Ca levels. Sr, when injected intravenously, disappears within 24 hrs. from the blood; serum Ca shows a rapid and prolonged decrease and P an increase after 5–6 hrs. There is no relation between filterable and total Sr, or filterable and total P of serum after

ingestion or injection of Sr. Sr is excreted mostly in the feces when ingested, in the urine when injected. When Sr is fed over a period of 20-40 days, 28-87% of it is excreted mostly in the feces. On discontinuance of Sr feeding it disappears rapidly from feces, more slowly from urine." (Chem. Abs. 37: 923.)

175. FORBES, R. M., and MITCHELL, H. H. Accumulation of dietary boron and strontium in young and adult albino rats. Amer. Med. Assoc. Arch. Indus. Health 16: 489-492. 1957.

"Rats fed rations contg. 73, 104, and 198 p.p.m. B as H_3BO_3 showed a depression of growth rate as the levels were increased. Retention of B in the body was inversely proportional to B concn. Rats fed ad libitum on a ration contg. 1000 p.p.m. B ate and gained less than those in the previous expt. Av. retention was 0.42%. Autopsy revealed no gross pathol. defects, nor evidence of riboflavin deficiency. Although 16-56% of the B was retained in the skeleton, which makes up less than 10% of the body weight, there is more total B in the soft tissues. The proportion in the skeleton decreases with advancing age of the animal. Feeding of Sr at levels of 30 p.p.m. (basal diet), 40, 130, and 1030 p.p.m. caused no apparent symptoms. The daily intake was 50 mg./kg. day, compared to an L.D.₅₀ of 795 mg./kg. by injection for albino mice. Food intake, weight gain, total bone ash, Ca, and P were unaffected. The percentage retention averaged 2.70% and accumulation occurred in the bones. The bone retention factor averaged 0.20, indicating preferential absorption of Ca." (Chem. Abs. 52: 3068.)

176. FRETTER, V. Experiments with radioactive strontium 90 on certain mollusks and polychaetes. Mar. Biol. Assoc. United Kingdom Jour. 32: 367-384. 1953.

"Since Sr resembles Ca qualitatively in its metabolic behavior and its radioactive isotope is more readily available, this element has been used in the study of various invertebrates. Uptake of Sr^{90} and its breakdown product Y^{90} was measured by means of autoradiographs. For their prepn. animals were fixed in abs. alc., cleared in xylene, embedded in paraffin, and sectioned to a thickness of not more than 10 μ . Sections were floated onto gelatin-coated slides and, after removal of the paraffin, were covered, with fine-grain stripping film which could be stored and developed at the appropriate time. In this way the concn. of the isotope by specific cells could be followed. Since Y^{90} has a half life of only 63.4 hrs., its activity may be neglected if the fixed tissues are set aside for 19 days before covering with film. When covered immediately after fixing, β particles from both Sr^{90} and Y^{90} were shown on the film emulsion. In *Arion hortensis* fed a diet contg. Sr^{90} the isotope was taken up by the digestive and lime cells of the digestive gland. Ca stores around blood vessels and in the mantle also concd. the tracer. *Aplysia punctata* and *Acanthodoris pilosa* obtain cations directly from the water as well as from the food and Sr^{90} was found in the Ca concretions of the mantle. In *Mytilus edulis*, *Patella vulgata*, and *Lepidochitona cinereus* Sr ions are taken in mainly through the gut and were found in the cells of the digestive gland and the intestinal wall. In *Mytilus* placed in sea water with an increased Sr^{90} content of 0.07%, the tracer was localized for excretion in the pericardial glands within 10 hrs. If the Sr content of the water was increased to 0.315%, within 3 days amoebocytes contg. Sr^{90} and Y^{90} were concd. in the labial palps and the blood spaces of the gills and then passed to the mantle cavity. There was no storage of Sr^{90} by the digestive gland, nor were high concns. retained by the mantle. The wandering lymphoidocyte cells of *Platynereis dumerli* concd. the isotope in the cytoplasm and transported it to the outer surface of the body." (Chem. Abs. 48: 2930.)

177. GREENBERG, D. M., and others. A study with radioactive isotopes of the permeability of the blood-cerebrospinal fluid barrier to ions. Amer. Jour. Physiol. 140: 47-64. 1943.

R. B. Aird, M. D. D. Boelter, W. W. Campbell, W. E. Cohn, and M. M. Murayama, joint authors.

"The permeability of the barrier between blood and cerebrospinal fluid to ions was studied by means of tracer experiments with their induced radioactive isotopes. The investigated ions were sodium, potassium, phosphate, and iodide, which are normally present in the body, and rubidium, strontium, and bromide, which are foreign to the body." (Author's summary.)

178. GRISWOLD, R. L., and PACE, N. The intracellular distribution of metal ions in rat liver. Expt. Cell Res. 11: 362-367. 1956.

"The distribution of K, Na, Ca, and Mg was studied among cell fractions of rat liver prepd. by differential centrifugation. About $\frac{1}{2}$ of the K and Na was found in the supernatant fraction but most of the Ca and Mg was located in the particular fractions." (Chem. Abs. 51: 1409.)

179. GROSCH, D. S., and LACHANCE, L. E. Fate of strontium-89 fed to Habrobracon females. Science 123: 141-142. 1956.

"Virgin females from wild type stock 33 of *H. juglandis* when fed with Sr^{89} citrate in honey (227 μ c./g. of mixt.) and kept at 30° show rapid decrease in radioactivity measured by thin end-window Geiger tube. Comparison was a dead animal to eliminate the rate of radioactive decay. Transection of the animals after several days show that 97.9% of the radioactivity was found abdominal. Eggs laid by the wasps were slightly radioactive, but only eggs within the first days after feeding. Eggs contain 0.03% of loss in radioactivity. These findings are contradictory to vertebrates, where the most part of P^{32} is incorporated into eggs and Sr^{89} is fixed in bone." (Chem. Abs. 50: 14989.)

180. HAMILTON, J. G. Metabolism of fission products. U.S. Atomic Energy Comm. MDCC-1000, 20 p. 1943.

Preparation of Ce^{140} without carrier; cerium tracer studies in rats; Sr^{85} studies, including methods employed for analyses of tissues, preparation of samples for counting, distribution of Sr^{85} in tissues of rat, recovery of Sr^{85} in rats, and daily measurements of excretion of Sr^{85} ; and decontamination studies—effect of experimental regimens on excretion of radioactive Sr.

181. HAMILTON, J. G., and others. Metabolism of fission products. U.S. Atomic Energy Comm. MDCC-1143, 20 p. 1943.

K. Scott, I. L. Chaikoff, M. C. Fishler, C. Entenman, R. Overstreet, L. Jacobson, M. Kaplan, and D. M. Greenberg, joint authors.

182. HIATT, R. W., and others. Radioisotope uptake in marine organisms with special reference to the passage of such isotopes as are liberated from atomic weapons through food chains leading to organisms utilized as food by man. U.S. Atomic Energy Comm. AT (04-3), 29 p. 1955.

H. Boroughs, S. J. Townsley, and G. Kau, joint authors. "Tuna fed Sr^{89} rapidly excretes the isotope. About 50 percent disappears within 2 hours, and at 24 hours only about 2 percent remains. Similar experiments with *Tilapia* show that about 4 days is required to reach the same leveling-off stage, which occurs at about 5 percent of the dose. Sr^{89} is rapidly taken up by all the organs. The biological half life of Sr^{89} in the internal organs varies from about 30 minutes in the cecum to about 20 hours in the midgut of the tuna. The half life of Sr^{89} in the structural tissues is apparently in excess of 1 year. Neither the size of the dose nor repetitive feeding affects the internal distribution of Sr^{89} or the percentage of the dose retained after several days. Less than 0.1 percent of the dose was excreted by *Tilapia* by way of the feces in 24 hours. *Caranx goides* picks up less than 0.25 percent of Sr^{89} offered it in solution in 24 hours. In most organs there is a fairly linear relationship between ash weight and either fresh or ash weight of the fish. Sr^{89} accumulates in the hyaline cartilage of fish eyes. Differences in specific activity

(c.p.m./mg. ash) indicate that the metabolism of Sr^{90} is different in bone and cartilage and that cartilage may have a greater avidity for radiostrontium than ossified tissue. Radioautographs of tuna integument show an increasing amount of Sr^{90} deposited in the scales over a period of time. pH values of freshly excised tuna organs are given. It is suggested that the greater percentage of retention of Sr^{90} in *Tilapia* integument, as compared with that in tuna, is a surface/volume effect. Because of its smaller size, *Tilapia* has a larger surface/volume ratio than has the tuna. The degree of vascularization is considered to be important in connection with the biological half life. The half life of Sr^{90} in the highly vascularized internal organs is short and is longest in the cartilage, which has the poorest supply of blood. External monitoring of the caudal fin with a G-M probe provides a simple means of predicting the entire amount of Sr^{90} in the tuna." (Author's summary.)

183. HIYAMA, Y., and ICHIKAWA, R. Up-take of strontium by marine fish from the environment. Rec. Oceanog. Works Japan 3: 78-84. 1957.

"In order to study the Sr up-take of fish from environmental waters, 2 series of expts. were conducted. In the first expt., designed to study the effect of different salinity of water on the uptake of Sr^{90} , *Acanthogobius flavimanus* was maintained in 3 tanks of varying dilns. of sea water to which Sr^{90} had been added so as to make the concn. approx. 1 μC . Sr^{90} /l. The fish were not fed for the 7-day period of the test. The data from this study showed that the 7 days in the Sr^{90} -contaminated water was long enough to replace the Sr in the muscle but not in the bone. In the 2nd expt., designed to study the effect of Sr^{90} uptake in different species of fish, *Fugu niphobles* and *Chasmichthys dolichognathus* were kept for 7 days in 2 larger tanks of sea water which contained about 1 and 10 μC . Sr^{90} /l. Data from this study showed greater variation in the Sr^{90} uptake by the individual fishes than did the first expt. The puffer and marine goby took up more Sr^{90} than did the common goby in the first study. In addn. to this, the fish reared in the 10 μC . Sr^{90} /l. tanks had accumulated about 10 times as much Sr^{90} as the fish in the 1 μC . Sr^{90} /l. tank." (Chem. Abs. 52: 6647.)

184. HODGKIN, A. L., and KEYNES, R. D. Movements of labeled calcium in squid giant axons. Jour. Physiol. 138: 253-281. 1957.

"Giant axons from *Loligo forbesi* soaked in artificial sea water contg. Ca^{45} for 2 hrs. and then washed in inactive sea water lost radioactivity rapidly at first (half-period about 15 min.) and then more slowly (half-period about 20 hrs.). Changing external Ca concn. from 22 mM to 112 mM increased the resting Ca influx only slightly but the extra Ca influx caused by elec. stimulation at 156 impulses/sec. was increased 20-fold. Stimulation at 50 impulses/sec. was ineffective." (Chem. Abs. 52: 1493.)

185. ICHIKAWA, R., and HIYAMA, Y. Distribution of radiostrontium to the various tissues of jackmackerel, mackerel, and tuna. In Research in the effects and influences of the nuclear bomb test explosions, compiled by the Committee for Compilation of Report on Research in the Effects of Radioactivity, v. 1, p. 1143-1151. Tokyo, Japan Society for the Promotion of Science, 1956.

186. KING, R. C., and RUBINSON, A. C. Distribution of calcium in adult *Drosophila melanogaster*. Science 125: 546. 1957.

"*D. melanogaster* flies of the Oregon-R strain were fed during larval and adult stages on *Saccharomyces cerevisiae* uniformly labelled with Ca^{45} . Autoradiograms of adults showed that Ca^{45} was uniformly distributed in the blood and tissue fluids and concn. only in terminal portions of the ant. malpighian tubules. ♂ and ♀ showed no difference in distribution of Ca which amounted to 165 p.p.m. in adults. There was no concn. of Ca in oocyte nuclei or sperm heads, and it is concluded that it plays no role in 'stabilising' the chromosomes." (Internatl. Abs. Biol. Sci. 8: 470.)

187. KRUMHOLZ, L. A., GOLDBERG, E. D., and BOROUGHS, H. Ecological factors involved in the uptake, accumulation, and loss of radionuclides by aquatic organisms. In National Academy of Sciences, National Research Council, The effects of atomic radiation on oceanography and fisheries, Report of the Committee on Effects of Atomic Radiation on Oceanography and Fisheries, NAS-NRC Pub. 551, p. 69-79. Washington, D.C., 1957.

Uptake, accumulation, and loss by living organisms of radioactive materials that may be added to or induced in an aquatic environment are discussed.

188. LASZLO, D. Biological studies on calcium, strontium, lanthanum and yttrium. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (10): 62-67. 1956.

Selected data are presented on Ca metabolism using Ca^{45} as a tracer, metabolism of radiostrontium, biological applications of radioactive rare earth metals, and effect of chelating agents on radiometal metabolism.

189. LOEFFLER, R. K. A quantitative study of percutaneous absorption. III. Effect of concentration and solubility on tracer absorption of Sr^{90} from intact and abraded skin and from muscle in the rat: Validity of surface counter technique. U.S. Nav. Radiol. Defense Lab. USNRDL Rpt. AD-290(B), 19 p. 1951.

"Absorption into the body of $\text{Sr}^{90}\text{Cl}_2$ in isotonic and saturated solutions of carrier SrCl_2 from intact and abraded rat skin was shown to be essentially independent of the concentration of the applied solution. Very little radiostrontium was found in the body 1 hr. after poorly soluble $\text{Sr}^{90}\text{SO}_4$ was applied to intact skin, abraded skin, and intramuscular laceration. However, an appreciable amount was found to have been absorbed ten days after intramuscular application. Values for percutaneous absorption obtained by surface-counting technique were shown to correlate closely with those obtained by direct analysis of ashed tissues." (Nuclear Sci. Abs. 5: 3633.)

190. LOEFFLER, R. K., and HERRON, J. W. A quantitative study of percutaneous absorption. V. Treatment of contaminated skin and wounds to prevent absorption of radioactive salts. U.S. Nav. Radiol. Defense Lab. USNRDL Rpt. AD-309(B), 21 p. 1951.

"Experimental data from previous reports (AD-225(B), 254(B), 290(B), 308(B)) on bodily absorption of $\text{Sr}^{90}\text{Cl}_2$ and $\text{Sr}^{90}\text{SO}_4$ through intact, mechanically-damaged, and thermally-burned skin were used as a basis for the testing of several methods and agents for treating contaminated skin and wounds. Pretreatment of skin, care of rats, preparation of contaminating material and general analytical procedures are explained. It was found that neither arterial nor venous tourniquets prevent absorption of radiostrontium chloride through either intact or abraded rat skin. However, a tourniquet exerting pressure greater than normal venous pressure will lessen absorption into the system. An arterial tourniquet will prevent absorption of material into the system. A variety of cleansing agents were tested alone and in combination. Some of them were tap water, tincture of green soap, Ivory soap, TiO_2 slurry, the disodium salt of ethylenediaminetetraacetic acid (EDTA), and tannic acid. Tide alone and with Epinephrine gave the best results as decontaminants. Epinephrine effectively hinders absorption, especially from abraded skin, during the first hour after contamination. Included is a discussion of possible practical applications of results." (Nuclear Sci. Abs. 5: 4996.)

191. LOEFFLER, R. K., HERRON, J. W., and THOMAS, V. A quantitative study of percutaneous absorption. IV. Absorption of minute quantities of radiostrontium chloride through burned rat skin. U.S. Nav. Radiol. Defense Lab. USNRDL Rpt. AD-308(B), 25 p. 1951.

"The effect of thermal burns on percutaneous absorption of radiostrontium chloride has been studied. Burns were given both before and after contamination of intact and abraded rat skin with radiostrontium chloride. Intact

skin with moderately severe or severe burns showed a tendency toward less absorption than unburned skin. This effect was noted when thermal energy was applied during the period from 24 hr. preceding application of strontium chloride to 5 min. following this contamination. No decrease in absorption was found following suberythral energy doses. Absorption through abraded skin varied when thermal energy was applied 1 min. after contamination. Specifically, in the suberythral and first-degree burn range, absorption tended to increase. In the second- and third-degree burn range, absorption decreased. A much greater concentration of absorbed strontium was found in tissues surrounding the contaminated, burned area than was found underneath contaminated skin that was normal or mechanically damaged. This was noted even at an energy dosage slightly below that causing visible skin change." (Nuclear Sci. Abs. 5: 4995.)

192. LOEFFLER, R. K., and THOMAS, V. A quantitative study of percutaneous absorption. I. Absorption of radiostrontium chloride in minute quantities through intact and mechanically damaged rat skin. U.S. Nav. Radiol. Defense Lab. USNRDL Rpt. AD-225(B), 25 p. 1950.

A percent-time relation study was made of the systemic absorption of minute quantities of neutral, soluble radiostrontium Sr^{89} through intact, abraded, and lacerated skin of rats and from wounds made by contaminated blades. It was found that the absorption was very rapid in all cases; much of the uptake took place in the first 10 minutes, and practically all within the first 0.5 hour. Slightly more than 10 percent of the contaminant was absorbed through intact skin, and nearly 50 percent reached the body interior when the continuity of the outer skin layers was broken. The type and degree of the discontinuity appeared to be of little significance. Three hundred roentgens of X-irradiation given 24 hours prior to contamination had little or no effect on the absorption rate through the abraded skin. The absorption rate was used as a test of the rate at which rat skin recovered after the outer layers were scraped off. It was found that absorption rates through abraded skin after 8 hours of healing were almost the same as those through normal skin.

193. MARINELLI, L. D., and others. Transport of radium sulfate from the lung and its elimination from the human body following single accidental exposures. Radiology 61: 903-915. 1953.

W. P. Norris, P. F. Gustafson, and T. W. Speckman, joint authors.

"Six persons who suffered single accidental exposures to RaSO_4 dust were examd. during the following year for exhalation of radon, and for γ -ray activity from the thorax and from the body as a whole. The ratio of exhaled Rn to total Ra burden is distinctly lower, especially during the first 6 months. The γ -ray scanning pattern easily discloses the sharp localization of the element in the lung. During the first year the γ -ray activity from the thorax decreases with an average half-life of the order of 120 days. The elimination pattern found in a single individual is characterized by early elimination of Ra swallowed and a relatively high elimination at later times, presumably sustained by release of the salt from the lung." (Chem. Abs. 48: 3550.)

194. MILHAUD, G., and AUBERT, J. P. A study of the general processes of calcium metabolism in man. Internatl. Jour. Appl. Radiation and Isotopes 2: 246. 1957.

"The injection of Ca^{45} in tracer quantity and the determination of the specific activity of calcium of the blood, urine, and feces permit the determination in the normal man of (1) rate of urinary and fecal excretion of calcium; (2) quantity of calcium that rapidly equilibrates with the blood calcium, i.e., circulatory calcium; and (3) rate of fixation in bone. This method permits the determination of the values of these different constants in the normal subject and the establishment of the important variations

in pathological cases (Paget's disease, osteoporosis, etc.)." (Author's abstract.)

195. PROSSER, C. L., and others. Accumulation and distribution of radioactive strontium, barium-lanthanum, fission mixture and sodium in goldfish. U.S. Atomic Energy Comm. MDDC-496, 40 p. 1945.

W. Pervinsek, J. Arnold, G. Svihla, and P. C. Tomkins, joint authors.

"Small nonfeeding goldfish accumulated radioactive strontium, barium-lanthanum, fission mixture elements, and sodium from solutions in which they were immersed. Accumulation was rapid initially and continued at a rate greater than the loss of radioactivity in the medium by decay and absorption. Hence, the ratio of the concentration of active material in the fish to that in the solution increased with time. After a few days this concentration ratio was usually between 10 and 100. The concentration ratio was independent of dose over the range investigated (0.01 $\mu\text{c.}$ to 1.0 $\mu\text{c./ml.}$). Calcareous tissues, such as skeleton and scales, accumulated about 75 percent of the radiostrontium and radiobarium in the whole fish. Lanthanum and a mixture of cerium, yttrium, and zirconium-columbium appeared to be accumulated in visceral tissues, especially the intestine, and to be more actively absorbed on feces and glass than were the alkaline earths. The comparable distribution, particularly of bone seekers, on immersion and injection indicated that these elements were taken up through gill and oral membranes and were distributed by the blood. Radiosodium was present in greater proportion in the gills at 6 hours than later. Fission mixtures shifted in abundance from soft parts to bony portions of the gills during the first few days. Injection experiments indicated that there was no fecal excretion of strontium but that there was a small amount of fecal excretion of Ba^{140} - La^{140} and of fission mixtures. Some fission mixtures components appeared to be taken out of the medium, either from feces or water, and precipitated along the intestinal folds. The yolk of eggs in ripe ovaries accumulated some components of fission mixture but not strontium or barium. Young growing or regenerating bone accumulated more radioactive material than did older bone; cartilage accumulated none of the bone seekers. Large mature goldfish accumulated radioactive material more slowly than did small fish. This may have been in part related to their calcium turnover. Uptake of strontium 89 and uptake of fission mixture were shown to be greater when the surrounding pond water was low in calcium (1.8 p.p.m.) than when it was high in calcium (36 p.p.m.). Inactive strontium also retarded the uptake of radiostrontium. When the fish were transferred from active to inactive pond water, they lost some Ba-La and fission mixture radioactivity from soft tissues during the first few hours, but they did not lose the major part of their radioactivity any faster than by decay alone. The rate of loss of radiostrontium appeared to be unaffected by the calcium content of the water. Goldfish were unable to desorb any appreciable quantities of fission elements from suspended clay." (Author's abstract.)

196. RAO, K. P., and GOLDBERG, E. D. Utilization of dissolved calcium by a pelecypod. Jour. Cell. and Compar. Physiol. 43: 283-292. 1954.

"With the aid of Ca^{45} it was shown that an important source of Ca for *Mytilus californianus* (I) is sea water. The mucus sheet of the gills provides an absorbing surface which is in a const. state of renewal. Mucus of *Ciona intestinalis*, *Styela montereyensis*, *M. edulis*, and *Anthopleura xanthogrammica* behaves similarly toward Ca. I is capable of directive localization of Ca in extremely well defined areas of the mantle where active repair of local injury to the shell is in progress. Within 24 hrs. 97.6% of mantle Ca turns over." (Chem. Abs. 48: 13107.)

197. SAUSEN, R. E. Electrophoresis in dentin with radioactive calcium. Jour. Dental Res. 34: 12-19. 1955.

"Electrophoresis will move 0.1 N Ca ion soln. through the full length of the dentinal tubules within 60 sec. with a current strength of 0.5 ma. properly applied, will move

a hypotonic concn. of ions against an unfavorable concn. gradient, and increase the concn. of supplied ions in areas of a lowered secondary conductance, but will not move Ca ions through enamel within the threshold of pulp tolerance. Electrophoretic satn. of tubules with exogenous Ca ions remains for at least 4 days if the cavity be sealed with Agamalgam. A favorable gradient assists electrophoresis." (Chem. Abs. 49: 8339.)

198. SHIRLEY, R. L., and others. Distribution of calcium-45 in tissues of a steer fed grass from land that received labeled fertilizer. Fla. Acad. Sci. Quart. Jour. 20: 133-138. 1957.

W. K. Robertson, J. T. McCall, J. R. Neller, and G. K. Davis, joint authors.

"Urinary and fecal excretion rates and tissue contents of Ca⁴⁵ detd. over a 6-day period in a steer fed grass grown on soil treated with CaCO₃ contg. the added isotope, were compared to similar detns. in another steer given a salt drench with added Ca⁴⁵. The source of the isotope had little effect on its deposition in the viscera and the urinary excretion. The fecal excretion was 41% in the grass fed steer as compared to 62% in the drenched animal." (Chem. Abs. 52: 1389.)

199. SOLOWAY, S., WELSH, J. H., and SOLOMON, A. K. Calcium⁴⁵ transport in crayfish nerve. Jour. Cell. and Compar. Physiol. 42: 471-485. 1953.

"The chela axons of *Cambarus virilis* were incubated for 1 hr. at 15° in van Harreveld's soln. (I) contg. Ca⁴⁵. After brief washing the nerves were incubated in nonradioactive I and the rate of loss of Ca⁴⁵ measured. The change in Ca⁴⁵ content with time was given by: $R = b(4.0e^{-0.0883t} + e^{-0.00487t})$ where $R = \text{Ca}^{45}$ content at time t , and b is an arbitrary const. Lowering the Ca concn. in I to 4mM did not affect the Ca⁴⁵ loss. The Q_{10} to 25° was very small or neg." (Chem. Abs. 48: 4668.)

200. SPODE, E., and GENSICKE, F. On the distribution of radio-active yttrium (Y⁹¹) in the body. Naturwissenschaften 44: 118-119. 1957.

"Radioactivity of blood, liver, spleen, kidney, pancreas and femur was measured at intervals from 30 min. to 30 days after subcutaneous or intraperitoneal injection of 0.2 ml. carrier-free ⁹¹YCl₃, activity 0.5 µc., into 88 white mice of both sexes. There were great differences in distribution with mode of injection. After subcutaneous injection activity was found in liver and kidney and after some days was high in bone, but most remained at site of injection. After intraperitoneal injection high values in bone were found earlier and activity in organs was higher; the very high activity of pancreas is ascribed to adsorption on the surface of the organ." (Nutr. Abs. and Rev. 27: 5321.)

201. STROHL, A., and others. Study with the aid of radioactive isotopes of the electrolytic introduction of ions [through the skin]. Soc. de Biol. [Paris] Compt. Rend. 144: 819-824. 1950.

J. Verne, J. C. Roucayrol, and P. F. Ceccaldi, joint authors.

"The elec. transport of radioactive I⁻ (from NaI) and radioactive Sr⁺⁺ (from SrCl₂) through the skin into the circulation of rats, guinea pigs, and rabbits is described and discussed." (Chem. Abs. 45: 1639.)

202. STUTTGEN, G., and BETZLER, H. The problem of electrolyte skin permeability. I. In vitro experiments with radioactive calcium, sulfate and phosphate ions in guinea pig and mouse skin. Arch. f. Klin. u. Expt. Dermat. 203: 472-482. 1956.

203. STUTTGEN, G., and BETZLER, H. Electrolyte permeation through the skin. II. In vitro and in vivo experiments in human skin with radiocalcium. Arch. f. Klin. u. Expt. Dermat. 204: 165-174. 1957.

EXCRETION AND TURNOVER OF STRONTIUM AND CALCIUM

204. ANTHONY, D., LATHROP, K., and FINKLE, R. Radiotoxicity of injected Sr⁸⁹ for rats, mice and rabbits. Part II. Metabolism and organ distribution. U.S. Atomic Energy Comm. MDCC-1363, 29 p. 1947.

Mice, rats, and rabbits excreted Sr⁸⁹-Sr⁹⁰ very rapidly after intraperitoneal or intravenous administration. The greatest part of the excretion took place during the first 3 days, and by 10 to 15 days virtually no more of the retained strontium was excreted. Average total excretion values were 54 percent of the injected dose for the mouse, 40 percent for the rat, and about 70 percent for the rabbit. Average total retention values were 45 percent of the injected dose for the mouse, 59 percent for the rat, and 21 percent for the rabbit. After 3 days almost all the retained Sr⁸⁹-Sr⁹⁰ was found in the skeleton. The concentration in bone was more than 100 times that in soft tissue. There does not appear to be any significant variation in retention of Sr⁸⁹ on a per gram basis between different types of bone. The logarithm of the retention, the rate of excretion, and the blood concentration of radioactive strontium in each case was found to be a straight-line function of time.

205. BAYLOR, C. H., and others. The fate of intravenously administered calcium. Effect on urinary calcium and phosphorus, fecal calcium and calcium-phosphorus balance. Jour. Clin. Invest. 29: 1167-1176. 1950.

H. E. Van Alstine, E. H. Keutmann, and S. H. Bassett, joint authors.

"Intravenously administered Ca gluconate (550 mg. Ca daily) was used to supplement the dietary intake of 3 human subjects: a normal woman, a woman with postmenopausal osteoporosis, and a man recovering from partial starvation. A considerable part of the Ca was excreted in the urine within 24 hrs. There was no demonstrable effect on fecal Ca. Some Ca was retained in each case, being greatest in the male and least in the woman with osteoporosis. There was a decrease in urinary Ca excretion in both females, perhaps because of depression of parathyroid activity. Intravenous Ca decreased the urinary excretion of P in all patients without increasing the fecal excretion, which is the converse of that seen when a sol. phosphate is given orally. In normal women, testosterone propionate and α-estradiol benzoate increased the retention of both Ca and P absorbed from the food, but not the retention of the Ca supplement. A small N-sparing effect was noted in the male and in the normal woman during periods of Ca gluconate injection. 22 references." (Chem. Abs. 44: 10923.)

206. BELLIN, J., and LASZLO, D. Metabolism and removal of Ca⁴⁵ in man. Science 117: 331-334. 1953.

"A tracer dose of Ca⁴⁵Cl₂ (0.75-100 µc./kg. body wt.) was injected into human subjects on a low-Ca diet, and blood, urine, and stool analyses made for Ca⁴⁵. Ca⁴⁵ rapidly disappeared from the blood stream, appeared in the excreta, and was deposited in bone, the rate depending on the state of bone metabolism. This may afford a more useful indicator of skeletal activity than criteria heretofore employed. In another patient, when the levels of Ca⁴⁵ approximated an equil. in the serum and excreta, the Na salt of ethylenediaminetetraacetic acid was infused intravenously for 6-hr. periods on 3 consecutive days. Excretion of Ca⁴⁵ was thereby increased 10-fold." (Chem. Abs. 47: 8200.)

207. BRINE, C. L., and JOHNSTON, F. A. Endogenous calcium in the feces of adult man and the amount of calcium absorbed from food. Amer. Jour. Med. 3: 418-420. 1955.

"The amount of Ca in the faeces when the food contains none was found by plotting the faecal Ca of subjects reported in 51 studies in the literature against dietary Ca

and extrapolating to zero. The faeces were estimated to contain 75 mg. per person per day of endogenous Ca. This figure was used in calculating the percentage of Ca absorbed in a compilation of reported studies which supplied intake and faecal values for Ca. The mean percentage absorbed on intakes from 400 to 599 mg. per day was 43; on intakes from 600 to 999 mg. it was 34 to 35; and on intakes from 1000 to 1199 mg. it was 28." (*Excerpta Med.* 10: 692.)

208. BRONNER, F., and others. Calcium metabolism. VI. Radiocalcium 45 metabolism in a moribund boy with gargoylism. *Fed. Proc.* 14: 429. 1955.

J. R. Moor, R. S. Harris, J. Kreplich, and C. E. Benda, joint authors.

"A 10-year-old moribund gargoyle patient was given 80.4 μ c. of radiocalcium 45 intravenously. Total calcium and calcium 45 were determined on samples of serum, urine, feces, and cerebrospinal fluid during the 15 days he survived, and on serum, bile, cerebrospinal fluid, and soft and hard tissues taken at postmortem. The rate of calcium 45 disappearance from his serum was about 50 percent as rapid as in healthy subjects (Bronner et al., XIX Internatl. Cong. Proc., p. 235, 1953), and is described by the equation:

$$C_t = 0.1395e^{-0.6112t} + 0.0265e^{-0.0612t} + 0.0157e^{-0.0109t} + 0.00331e^{-0.000991t}$$

where C_t = specific activity of a serum (percent dose/mg. Ca) and t = time (minutes). The specific activity of the urine paralleled that of the serum, but was generally lower; the reverse was noted in healthy subjects. The calcium 45 ratio of urine to feces was one-tenth that observed in healthy subjects. The calcium 45 content of the cerebrospinal fluid had equilibrated with the serum 6 hours after injection. The specific activities of the bile and soft tissues taken at autopsy were the same as those of the post-mortem serum. Though the specific activities of the various bones and different areas of each bone varied greatly, the average was about one-sixteenth that of the serum. On the basis of bone data, the retention of calcium 45 during 14 days was 91.7 percent; on the basis of excreta data the retention was calculated to be 87 percent." (Author's summary.)

209. CAUSERET, J. Influence of water consumption on intestinal and renal elimination of Ca. *Acad. des Sci. Paris, Compt. Rend.* 237: 664-665. 1953.

"Increased fluid ingestion by the rat was shown to increase greatly the urinary and fecal excretion of dietary Ca. The significance of this finding with respect to decreased absorption of Ca is indicated." (*Chem. Abs.* 48: 3503.)

210. CHEN, P. S., JR., and NEUMAN, W. F. Renal excretion of calcium by the dog. *Amer. Jour. Physiol.* 180: 623-631. 1955.

"Ca reabsorption by the renal tubules is an active process normally exceeding 99% of that filtered. The small but const. amts. of Ca excreted are thought to be an un-ionized complex. Ca excretion is increased following the intravenous injection of Na_2HPO_4 or tetra-Na Versene. The increased serum inorg. phosphate concn. following intravenous Ca administration was accompanied by a compensating fall in red-cell org. phosphate esters." (*Chem. Abs.* 49: 10486.)

211. CHEN, P. S., JR., and NEUMAN, W. F. [Renal reabsorption of calcium through its inhibition by various chemical agents. *Amer. Jour. Physiol.* 180: 632-636. 1955.

"The active reabsorption of Ca is depressed by the metabolic inhibition produced by phlorizin, dinitrophenol, and Na azide and by the simultaneous reabsorption of Sr. Na and K excretion were relatively unaffected by these agents and diamox, which increases Na and K excretion greatly, had no effect on Ca reabsorption. Pentobarbital anesthesia greatly enhanced Ca, Na, and phosphate excretion but did not affect K or water excretion." (*Chem. Abs.* 49: 10486.)

212. COMAR, C. L., and others. Comparison of two isotope methods for determination of endogenous fecal calcium. *Jour. Nutr.* 50: 459-467. 1953.

R. A. Monroe, W. J. Visek, and S. L. Hansard, joint authors.

"Comparable values have been obtained for endogenous fecal Ca in cattle by an isotope diln. method and a comparative balance method. Both procedures involve the use of Ca^{45} , but they are different in principle. The former offers advantages in being independent of the availability of the dietary Ca and of the uncertainties of balance detns." (*Chem. Abs.* 47: 12479.)

213. COPP, D. H., and THOMSON, D. M. Radiocalcium turnover and excretion in adult, young, and rachitic rats. *Amer. Jour. Physiol.* 167: 775-776. 1951.

"The report is reproduced here in its entirety. The bone turnover and urinary excretion of radiocalcium (Ca^{45}) was studied in mature female rats, in normal young animals 2 months old, and in rats of the same age made rachitic by restricting them to a synthetic low-phosphorus diet from weaning. They were sacrificed at intervals up to 16 days following I.V. injection of Ca^{45} .

Initial bone uptake of Ca^{45} was rapid in both groups of young animals. In the normals, it remained fixed in the skeleton; in the rachitic rats it appeared "labile," and was rapidly removed. Uptake in adult bone was slower. Urinary excretion of radiocalcium was very high in the rachitic group, and the renal clearance of Ca^{45} was 10 to 15 times as great as in young or adult normal animals. This suggests a direct effect of low-phosphorus rickets on calcium excretion by the kidney." (*Nuclear Sci. Abs.* 5: 5035.)

214. FINLAY, J. M., NORDIN, B. E. C., and FRASER, R. Calcium-infusion test. II. "Four-hour skeletal retention" data for recognition of osteoporosis. *Lancet* I: 826-830. 1956.

In 10 normal patients the 4-hour skeletal retention of Ca was 50 to 62 percent. In all 8 patients with osteomalacia due to steatorrhoea and in 5 of 7 patients with steatorrhoea without obvious osteomalacia the 4-hour skeletal retention was above normal. In 11 of 15 patients with osteoporosis the 4-hour skeletal retention was below normal although the 0- to 12-hour urinary excretion of Ca was abnormal in only 4.

215. FRAU, F. Effect of strontium chloride on renal elimination of water and sodium chloride. *Arch. di Farmacol. Sper. e Sci. Aff.* 62: 77-90. 1936.

"Doses of SrCl_2 up to 0.001 g. equiv./kg. increased urine vol. and NaCl elimination of rabbits after intravenous injection of hypertonic NaCl soln. Larger doses produced a diminution of vol. and NaCl elimination." (*Chem. Abs.* 31: 2287.)

216. FREEMAN, S., JACOBSEN, A. B., and WILLIAMSON, B. J. Acid-base balance and removal of injected calcium from the circulation. *Amer. Jour. Physiol.* 191: 377-383. 1957.

"A marked increase in the rate of removal of injected Ca was observed to occur in all dogs having high plasma bicarbonate values, except those with respiratory acidosis. The most rapid removal of injected Ca, approx. 5 times the normal rate, occurred in dogs with alkali excess compensated by the inhalation of high concns. of CO_2 . This was not accounted for by increased excretion in the urine. These animals had normal pH values. The Ca space was reduced in NH_4Cl acidosis, but the slope of the disappearance curve for Ca was normal. CO_2 excess was accompanied by an elevation of the plasma concn. of inorg. phosphate." (*Chem. Abs.* 52: 4795.)

217. GEISSBERGER, W. Ca resorption and retention in human subjects after intravenous, oral, and rectal calcium administration with a balance (dose-recovery experiments) using radioactive calcium. *Ztschr. f. die Gesam. Expt. Med.* 119: 111-142. 1952.

"The normal serum Ca level of 9-11 mg. % was un-

changed by rectal Ca administration. Between 70 and 80% of a rectal Ca infusion was recovered 1, 2, and 3 hrs. later; comparable amts. of unabsorbable BaSO₄ were recovered, indicating absence of Ca absorption. Seven days after intravenous injection of 1 g. Ca⁴⁵ gluconate (I) 20.1 and 16.7% of the radioactivity were recovered in urine and feces, resp., of a normal subject, 18.7 and 7.9% in a constipated patient, 6.3 and 22.0% in a coronary insufficiency case. Seven days after oral intake of 1 g. (I) 6.5 and 68.4% of the dose were found in the urine and feces, resp. After application of 1 g. (I) in a rectal suppository or 0.5 g. in 5% soln., no activity appeared in the urine; 92-99% was recovered in the feces. Following 8 daily oral doses of 1 g. (I) 1.6, 2.6, and 2.7% of the total amt. was found in the urine and 51, 72, and 72.5% in the feces after 8, 14, and 17 days. Similarly after intravenous injections 29, 35, and 37% were in the urine, 11, 15, and 17% in the feces. The corresponding Ca retention was 47, 26, 25 and 60, 50 and 48% after oral and intravenous administration, resp. Seven days after a single intravenous (I) dose, the retention was 65, 73, 77, 75, and 72% in a normal, constipated, osteoporosis, steatorrheic, and coronary insufficiency cases, resp. 45 references." (Chem. Abs. 47: 4462.)

218. HAMILTON, J. G. Summary of metabolism of carrier-free fission products in the rat. U.S. Atomic Energy Comm. MDDC-1002, 3 p. 1947.

A table listing oral absorption and percent deposition of absorbed fraction and retention at 4 days after parenteral administration; excretion, route, and daily rate after parenteral administration; and retention in lungs and other organs after direct administration into lungs. Elements listed are Sr⁸⁵, Y⁸⁶, Zr⁸⁹, Nb⁹³, Ru¹⁰⁵, I¹³¹, Xe¹²⁷, Ba¹³³, La¹⁴⁰, and Ce¹⁴⁰.

219. HARRISON, G. E., RAYMOND, W. H. A., and TRETHEWAY, H. C. The metabolism of strontium in man. Clin. Sci. 14: 681-695. 1955.

"The turnover of Sr was measured in subjects on a normal diet before and after administration of SrCl₂. Sr was analyzed by exposing exts. of plasma or excreta and a standard Sr compd. to a neutron flux, and the radioactive Sr measured. An intravenous injection of 20 or 100 mg. of Sr as the chloride was given to 2 subjects. The cumulative Sr in the urine after one month was 66% of the dose, while only small amts. were in the feces. After an oral dose of Sr as the chloride, fecal excretion was 64% of the dose in 30 days. Urinary excretion was about 24% of the dose with a retention of 10-12%." (Chem. Abs. 50: 10925.)

220. HARRISON, G. E., RAYMOND, W. H. A., and TRETHEWAY, H. C. The estimation of barium and strontium in biological materials by activation analysis with special reference to the turnover of strontium in man. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (11): 156-159. 1956.

221. HEVESY, G. Conservation of skeletal calcium atoms through life. K. Danske Vidensk. Selsk., Biol. Meddel. 22: 1-23. 1955.

"Ca⁴⁵ was used to det. retention of Ca in mouse skeletons. Mother mice were given drinking water contg. labeled Ca⁴⁵ in 150 mg. of CaCl₂/l. and fed a diet contg. 188 mg. Ca/100 g. This was started 2 to 10 weeks before parturition. In one series of expts., the young mice and the mothers were continued on the labeled diet until the young mice were outgrown (at about 100 days). In another series, new-born mice were shifted immediately to inactive mothers. By sacrificing members of a given litter at various times, it was possible to measure change in Ca⁴⁵ content with time relative to that of the mother. In the first type of expt., 7 litters gave an av. of 64.7 ± 7.3% retention of Ca⁴⁵ after 390 days from the time when they were outgrown. In the 2nd. type of expt., in one litter 53% of the Ca⁴⁵ was lost between day 3 and day 560, and in another 44%. It was also found that Ca⁴⁵ ingested by the mother mouse exchanged only with about

1/2 to 1/3 of the mother's body Ca before going into the embryo. This result can be used to calc. that the 11th generation contains no Ca atoms from the first. During all these expts. the Ca⁴⁵ activity of the mice remained below 0.05 µc./g., so no radiation effects were expected." (Chem. Abs. 50: 3595.)

222. HEVESY, G. The path of the atoms through the generations. Naturw. Rundschau 9: 212-214. 1956.

"Tracer expts. indicated that in man all intracellular Na and the part of the mineral bone Na which is not extremely stably bound is exchanged with extraneous Na (administered through food) within approx. 162 weeks. The fate of the Ca atoms is redetd. by breeding a generation of mice with a const. activity in Ca⁴⁵ (0.5 µc.). After 1 year subsequent stoppage of feeding tagged Ca, 67 ± 7.9% of the original Ca is still found in the skeleton. In another series the Ca content of descendants from an active mother, being reared by untreated animals and later sustained on untagged food, was examd. for 1.5 years. During the intense growth period within the few weeks after birth the loss of Ca⁴⁵ is considerable; however, it does not amt. to more than 50% within a lifespan. Extrapolation yields, in general, that all of the original Ca atoms will have been exchanged in the 11th to 12th generation. The substitution of H₂O mols. and P atoms is reviewed." (Chem. Abs. 50: 13232.)

223. HEVESY, G. Renewal of the mineral constituents of the skeleton. Internatl. Jour. Appl. Radiation and Isotopes 2: 85. 1957.

"Experiments with Ca⁴⁵ in mice showed that the eleventh generation contained no Ca atom present in the first generation of its ancestors." (Nutr. Abs. and Rev. 27: 5291.)

224. JODREY, L. H. Studies on shell formation. III. Measurement of calcium deposition in shell and calcium turnover in mantle tissue using the mantle-shell preparation and Ca⁴⁵. Biol. Bul. 104: 398-407. 1953.

"To det. rate of Ca deposition mantle-shell preps. of *C. virginica* were placed in 1 l. of sea water with a Ca⁴⁵ activity of 3.45 µc. After 8, 12, and 24 hrs. preps. were removed and the radioactive Ca deposited on the shells was detd. as previously described. The amt. of Ca deposited in 24 hrs. by a mantle-shell prep. of an oyster 8 cm. long was calcd. to be 1.27 mg.; for the whole oyster, 11.08 mg. Distribution of newly deposited Ca was similar in both. To det. Ca turnover rate mantle-shell preps. were placed in 500 ml. of sea water with a Ca⁴⁵ activity of 5.8 µc. until Ca⁴⁵ in the mantle reached equil. (4 hrs.). The mantle edge was sepd. and both portions were analyzed for Ca⁴⁵. Most of the Ca in the mantle was inert. A small fraction (2.4%) was renewed every 24 min., the turnover rate being 0.6 mg. Ca/min./g. of mantle. The Ca turnover rate in the mantle edge was approx. twice that in the mantle interior. Since this portion represents only half of the total Ca, the specific activity was the same for both portions. The amt. of Ca being renewed in the mantle approximated the amt. being deposited on the shell, indicating that the fraction of rapid turnover brought about shell formation." (Chem. Abs. 47: 8269.)

225. JONES, D. C., and COPP, D. H. The metabolism of radioactive strontium in adult, young, and rachitic rats. Jour. Biol. Chem. 189: 509-514. 1951.

"The metabolism of carrier-free radio-Sr was studied in adult, young, and rachitic rats during the crit. first 24 hrs. after intraperitoneal injection. Radio-Sr is removed from the plasma much more slowly in the adult animals than in the other 2 groups. The uptake by adult bone is continuous for the first 2 hrs., and reaches a max. within 4 hrs. Skeletal uptake of radio-Sr is much more rapid in the young animals, reaching a max. within 30 min.; very little was lost in the urine. The deposited isotope remains fixed in the bone. In rachitic rats, the rapid initial uptake was similar to that in the normal young animals, but was followed by active loss from the skeleton; only 1/2 was

left after 24 hrs. A labile combination with bone is indicated. A large part of the dose of radio-Sr was excreted by the rachitic rats within the first 24 hrs., and the plasma clearance was 10-15 times as great as in the normal animals. Rickets may have a direct effect on excretion by the kidney." (Chem. Abs. 45: 6260.)

226. JOWSEY, J., and others. Retention and excretion of Sr^{90} by adult rabbits. Brit. Jour. Expt. Path. 36: 22-26. 1955.

M. Owen, M. Tutt, and J. Vaughan, joint authors.

In rabbits aged 1 year or more, injected Sr^{90} is retained in scattered building sites in the cortical bone and in low calcification areas in endosteal and periosteal bone. The total amount retained is less than in young animals, but it is highly concentrated. Daily urinary excretion is irregular but continues long after the injection.

227. KAWIN, B., COPP, D. H., and HAMILTON, J. G. Studies of the metabolism of certain fission products and plutonium. U.S. Atomic Energy Comm. UCRL-812, 120 p. 1950.

The distribution and excretion of radioisotopes of cerium, columbium, plutonium, strontium, yttrium, and zirconium were studied in adult female rats of the Long-Evans strain. The metabolism of Pu (VI) was unaltered by general treatment with the sulfhydryl compounds, 2,3-dimercaptopropanol (BAL) and cysteine. This suggests that the metabolism of plutonium is not related to that of sulfhydryl groups. These compounds do not appear to be usable as therapeutic agents for plutonium poisoning. Cysteine appeared to increase the amount of plutonium retained at the site of intramuscular injection. Parathormone had no significant effects on the distribution and excretion of either plutonium or yttrium. The resorption of bone by parathormone did not appear to labilize these bone-deposited elements nor make them more susceptible to the positive effects of zirconium citrate. Massive doses of zirconium citrate appeared to have some positive effects on the distribution and excretion of cerium, columbium, plutonium, and yttrium. Sodium citrate had relatively little effect on the metabolism of these elements, with the exception of yttrium. Both citrates were without significant effect on the metabolism of radiostrontium. Zirconium citrate may alter the metabolism of the several radioisotopes through a "carrier" action as a chelated radiocolloidal citrate complex. The possible influence of this complex on the uptake and excretion of the several radioisotopes during the first hour after their administration is discussed.

228. KIDMAN, B., TUTT, M., and VAUGHAN, J. The retention and excretion of radioactive strontium and yttrium (Sr^{89} , Sr^{90} and Y^{90}) in the healthy rabbit. Jour. Path. and Bact. 62: 209-227. 1950.

"Studies were made on the metabolism of a mixt. of Sr^{89} , Sr^{90} , and Y^{90} in 5 and 7 weeks, and 6 and 18 months old rabbits on different diets. Carrier (nonradioactive Sr) in the amt. given was without effect on the retention or excretion of Sr. The previous finding that Sr is retained almost entirely in the skeleton was confirmed. Sr retention was greater on a low Ca diet, and in young rabbits. Fecal excretion was less affected by diet and age than was urinary excretion. In the low Ca group, irrespective of age, fecal exceeded urinary excretion. Excretion in both urine and feces was greatest at 6 months, except for the low Ca group, where it was greatest in the weanlings. The amt. of Y^{90} in the bones after injection was roughly equal to that of Sr^{90} , suggesting that the hazards of any Sr^{90} intake are considerably enhanced by the retention of Y^{90} emitting high β -particles. Analysis of decay curves on excreta suggests that Y^{90} excretion is greater in older animals. The use of decay curves is helpful in studying the differential metabolism of mixed isotopes." (Chem. Abs. 45: 6753.)

229. KIRPICHNIKOV, V. S., SVETOVIDOV, A. N., and TROSHIN, A. S. Absorption and elimination of

radioactive calcium by *Daphnia*, *Cyclops*, and guppy. Akad. Nauk S.S.S.R. Dok. 110: 1122-1125. 1956.

" $\text{Ca}^{45}\text{Cl}_2$ introduced through food and surrounding water accumulates in *Daphnia* rapidly in the first 0.5-1.0 hr., then the rate declines, but the final level is 360% of the level in the environment. *Cyclops* gave a similar result. Decline of Ca^{45} content in these species after being placed in pure water is rapid, with 50% being lost in 0.5 hr. The Ca^{45} activity of guppies which feed on the above 2 species is shown to increase steadily with time; most of the activity is caused by direct absorption of Ca^{45} from the surroundings as the isotope is being released by the labeled *Cyclops* or *Daphnia*. The rate of such direct absorption of Ca^{45} is quite high and the longer the exposure the longer it remains at a high level after the fish is placed in pure water." (Chem. Abs. 51: 6891.)

230. KISIELESKI, W. E. The distribution and excretion of Sr^{90} - Y^{90} in the dog. U.S. Atomic Energy Comm. ANL-5247, p. 68-71. 1954.

231. KURLYANDSKAYA, E. B., BELOBORODOVA, N. L., and BARANOVA, E. F. The distribution and elimination of radioactive strontium during its chronic administration to rabbits per os. Mater. Toksikol. Radioaktiv. Veshch. (Moscow: Gosud. Izdatel. Med. Lit.) Sborn. 1: 16-23. 1957.

" Sr^{89} was administered to rabbits per os daily for a long period at the rate of 2.7 microcuries/g. of body wt. The bony structure retained 92% of Sr^{89} with this level persisting for 4 months. The elimination of Sr^{89} from the organism takes place primarily in the feces, 11% during the early days of administration and 92% of the daily administration for 12-24 months after daily administration of the Sr^{89} was initiated. Only 1.7% was eliminated daily in the urine." (Chem. Abs. 52: 2263.)

232. LOONEY, W. B., and others. A summary of radium and thorium excretion in humans. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (11): 55-64. 1956.

J. B. Hursh, V. E. Archer, L. T. Steadman, and M. Colodzin, joint authors.

233. McCANCE, R. A., and WIDDOWSON, E. M. The fate of strontium after intravenous administration to normal persons. Biochem. Jour. 33: 1822-1825. 1939.

"Daily doses of 47 mg. of Sr were injected intravenously into 2 normal subjects for 5 days. The Sr was excreted slowly, 90% of it by the kidney." (Chem. Abs. 34: 2935.)

234. NORDIN, B. E. C., and FRASER, R. Calcium-infusion test. I. Urinary excretion data for recognition of osteomalacia. Lancet I: 823-826. 1956.

"Ca is administered as the gluconate over 4 hr. in physiological saline soln. The net urinary excretion of Ca during the first 12 hr. after the start of infusion was 33 to 53% in 21 normal patients and 2 to 27% in 12 patients with definite osteomalacia. In 18 cases of osteoporosis the excretion was within or above the normal range." (Internatl. Abs. Biol. Sci. 5: 828.)

235. NORRIS, W. P., SPECKMAN, T. W., and GUSTAFSON, P. F. Studies of the metabolism of radium in man. Amer. Jour. Roentgenol., Radium Ther. and Nuclear Med. 73: 785-802. 1955.

"The concept of a well-defined biol. half-time of Ra in bone is inconsistent with the long-term data presented, and an alternative is offered. Previously published information, which shows that the retention and excretion of Ra in animals may be represented as power functions, has been extended to the analysis of comparable studies in humans. The data presented are compatible with this form as are existing data in the literature. The use of the power function enables the derivation of the equation of retention from that of the excretion function or vice versa. Since methods are available to det. both total Ra burden and daily excretion of Ra, it is now possible to use the

daily coeff. of elimination as an index of elapsed time since exposure to a single equiv. dose of Ra, provided, of course, that sol. salts are known to have been involved and that allowance is made for the possibility of very recent exposures. The retention of intravenously injected Ra in the human has been measured as 0.6% of the original dose after 22 years." (Chem. Abs. 49: 9144.)

236. POSIN, D. Q. Investigations with radioactive Sr, P, and Fe. Mont. Acad. Sci. Proc. 3-4: 10-15. 1942-43.

"Four days before giving birth to young, a pregnant rat was given an injection of radioactive P. One of the young, less than a day old, showed considerable body and skeleton radiation. After about 2 months the radioactive P was about equally distributed in density in the young and the mother. A hen injected with radioactive Sr laid 8 radioactive eggs. The first egg was boiled for 20 min. and it was found that some activity was present in the white, practically none in the yolk, and the shell was very active. When the hen stopped producing Sr-radioactive eggs, radioactive Fe was injected and the eggs laid for several days thereafter were found to be radioactive. The activity was exclusively in the yolk. Saline washings of *E. coli* grown on a medium contg. radioactive P were radioactive. This activity was most marked in the first washing and was almost negligible in the 4th. The sedimented mass was very radioactive. When a suspension of this mass was injected in a rat the bacteria hovered principally near the point of injection. A radio-autograph of a rat injected with Sr⁸⁹ showed the leg-bone to be more active than the marrow, and the skull more active than the brain. The relative distribution of radioactive P and Sr in rats is shown by other radio-autographs." (Chem. Abs. 39: 3202.)

237. POULOS, P. P. The renal tubular reabsorption and urinary excretion of calcium by the dog. Jour. Lab. and Clin. Med. 49: 253-257. 1957.

"Ca was infused into normal dogs reaching a plasma concn. of 8.3-37 mg./100 ml. More than 99% of the filtered Ca is reabsorbed by the renal tubules. In most expts. the infusion of CaCl₂ or Ca gluconate produced a sharp fall in glomerular filtration rate, but in several no change in filtration rate occurred. Acidosis and hyponatremia developed in the presence of elevated Ca." (Chem. Abs. 51: 11565.)

238. PYRAH, L. N. Conditions in which calcium salts are deposited in the kidneys. Brit. Jour. Urol. 27: 333. 1955.

"Urinary Ca excretion (I) of 350 mg./day is considered to be the upper limit in normal persons. The range of (I) in 162 patients with renal calculi varied widely, 13 having an output below 50 mg./day, others excreting up to 800 mg./day. A great increase of (I) and alk. urine was found during enforced recumbency in cases of fractures or tuberculosis of the spine or pelvis; the max. of (I) was reached after 2-5 weeks of recumbency. So-called mud stones of pure Ca phosphate were found in these cases. Renal stones as the only clinical sign of hyperparathyroidism were seen in 16 of 51 cases, mostly accompanied by serum Ca levels of 11-17 mg.% and plasma P of 1.5-3.5 mg.%. Renal calcification may also be caused by peptic ulceration of the stomach or duodenum." (Chem. Abs. 51: 5256.)

239. ROSENTHAL, H. L. Uptake and turnover of calcium-45 by the guppy. Science 124: 571-574. 1956.

"The rate of uptake of radioactive Ca⁴⁵ (I) by *Lebistes reticulatus* (II), increased linearly during a 29-day test period of concns. of (I) which ranged from 10⁴ to 10⁶ counts/ml./min. The log of the rate of accumulation of (I) by (II) increased directly with the log of the concn. of (I). Rate of uptake of (I) by (II) decreased directly with concn. of inert Ca. When (II) was placed in H₂O free of (I), loss of radioactivity occurred in 3 major components. First, with a half-life of 3 days, (I) was lost from the soft body tissues and body surfaces; second, with a

half-life of 137 days, (I) was lost from muscles and connective tissues; and third, with a half-life of greater than 300 days, (I) was lost from the osseous tissues. The greatest uptake of (I) occurred in osseous tissues." (Chem. Abs. 51: 3054.)

240. SACHER, G. The excretion, retention, distribution, and clinical effects of strontium-89 in the dog. Part II. Statistical analysis of excretion and retention of strontium-89 for individual dogs. U.S. Atomic Energy Comm. AEC-D-2108, 18 p. 1946.

Excretion data of 17 dogs injected with Sr⁸⁹ were analyzed. Errors of estimate were also computed. The analysis of data was made in an attempt to determine quantitative aspects of the catabolic behavior of a tracer substance in individual animals.

241. SAMACHSON, J., SPENCER, H., and LASZLO, D. Urinary and gastrointestinal excretion of calcium and strontium in man. Fed. Proc. 17: 408. 1958.

"Because of the growing importance of Sr⁹⁰ in radioactive fallout, the study of its absorption, excretion, and deposition in bone is of considerable interest. The ability to predict the amount of radiostrontium excreted in different individuals may be of practical importance. From a study of more than 40 adults who received tracer doses of Sr⁸⁵ either orally or intravenously, it has been possible to indicate by means of empirical equations a relationship between urinary calcium and Sr⁸⁵ excretion for the first day and for a 12-day period. The data showed considerable scatter, but are nonetheless useful for predicting Sr⁸⁵ excretion from the stable calcium excretion alone. Better correlation is obtained between renal clearance of calcium and Sr⁸⁵, so that strontium clearance can be predicted from the knowledge of the clearance of calcium. Sr⁸⁵ clearance can be used to show how the radiostrontium excretion will depend on calcium excretion in various individuals, whether the isotope is administered orally or intravenously in single doses as has been done with Sr⁸⁹ or is ingested in minute quantities as is true for Sr⁹⁰. Factors affecting the variability of Sr⁸⁵ and calcium excretion are discussed and the reproducibility of radiostrontium excretion is calculated from the daily urinary calcium excretion. The relationship between urinary and fecal excretion of Sr⁸⁵, as well as between excretion and deposition in bone, is also discussed." (Author's abstract.)

242. SCHILLING, A., and LASZLO, D. Rate of urinary calcium excretion following its intravenous administration as an indicator of bone metabolism. Soc. Expt. Biol. and Med. Proc. 78: 286-289. 1951.

"The rate of excretion of Ca after slow intravenous infusion of 446 mg. of Ca as gluconate in a period of exactly 4 hrs. in normal subjects and patients with various bone diseases was detd. at intervals for 48 hrs. Subnormal rates were found in patients with an increased tendency to bone deposition. Increased rates were found in patients with osteolytic activity. The good correlation between these data and metabolic balance studies suggests the usefulness of this test in defining the state of skeletal activity and the effects of therapy thereon." (Chem. Abs. 46: 1640.)

243. SPENCER, H., and others. Strontium-85 metabolism in man and effects of calcium on strontium excretion. Soc. Expt. Biol. and Med. Proc. 91: 155-157. 1956.

M. Brothers, E. Berger, H. E. Hart, and D. Laszlo, joint authors.

"Carrier-free Sr⁸⁵ (γ-emitting, half-life 65 days), 0.1-0.4 microcuries/kg. body wt. was injected intravenously in 4 human subjects. The plasma levels of Sr⁸⁵ declined rapidly. The main route of excretion was via the kidneys. A small fraction of the dose appeared in the feces. Most but not all was eliminated in 16 days. The rate of Sr excretion seems to be influenced by the state of bone metabolism. It was slow in a patient with Paget's disease and rapid in a 72-yr.-old woman with senile osteoporosis. Simultaneous intravenous infusion of Ca gluconate significantly enhanced Sr excretion." (Chem. Abs. 50: 7305.)

244. STOVER, B. J., and ARNOLD, J. S. Concentrations of Ra^{226} and Ca^{45} in blood, bone, and excreta after intravenous injection. *Radiation Res.* 1: 563. 1954.

In a double tracer experiment Ra^{226} and Ca^{45} were administered simultaneously to a 5-month-old beagle puppy, which was sacrificed at 24 hours. By comparing the ratio of Ca^{45} to Ra^{226} originally injected with the ratios in blood, in forming and mature bone and in excreta, the difference between calcium and radium metabolism was demonstrated. Initially the blood ratio appeared unchanged; by 1 hour the ratio had increased and the Ca^{45} concentration remained greater than the Ra^{226} concentration. In the excreta the ratio decreased by a factor of 10, showing a marked preferential radium excretion. The bladder contents at 24 hours showed a greater decrease, indicating that the renal clearance of radium may be considerably greater than that of calcium. Radioautographically localized areas of mature and forming bone were isolated by microdissection and separately analyzed. The ratio in forming bone was unchanged but increased in mature bone. This indicates that forming bone in which the Ca^{45} and Ra^{226} were initially deposited was not in equilibrium with the blood after 1 hour, whereas mature bone tended to equilibrate with the blood. These observations are consistent with the concept of a slow rate of recrystallization in mature bone and a fast rate in forming bone.

245. STOVER, B. J., and ATHERTON, D. R. Sr^{90} plasma concentration—a preliminary report. *Utah Univ. Radiobiol. Lab. Ann. Prog. Rpt.* 1956: 107–108. 1956.

A preliminary comparison of the concentrations of Sr^{90} and Ra^{226} in the plasma of young adult beagles was made as a function of time after injection. These early data are consistent with the fact that strontium metabolism more closely resembles calcium than radium metabolism.

246. STOVER, B. J., and others. Early excretion of Sr^{90} . *Utah Univ. Radiobiol. Lab. Ann. Prog. Rpt.* AT (11-1): 119. 1958.

D. R. Atherton, E. F. Holt, and E. Wetzker, joint authors.

"The rate of excretion of Sr^{90} during the first 22 days after injection was determined for young adult beagle dogs. The continuous excretion data permitted direct calculation of retention, which followed the power function (R in percent dose and t in days)." (Author's abstract.)

247. STREHLER, E. Effect of calcium on renal function. I. Influence of calcium gluconate on glomerular filtration diuresis, and specific gravity of urine. *Ztschr. f. die Gesam. Expt. Med.* 127: 499–507. 1956.

248. SUYEHIRO, Y., and others. Transmission and metabolism of Sr^{90} in aquatic animals. In *Research in the effects and influences of the nuclear bomb test explosions*, compiled by the Committee for Compilation of Report on Research in the Effects of Radioactivity, v. 1, p. 1134–1141. Tokyo, Japan Society for the Promotion of Science, 1956.

S. Yoshino, Y. Tsukamoto, M. Akamatsu, K. Takahashi, and T. Mori, joint authors.

249. SWIFT, M. N., and PROSSER, C. L. The excretion, retention, distribution and clinical effects of strontium-89 in the dog. Part I. Report of experimental work. U.S. Atomic Energy Comm. MDCC-1388, 63 p. 1947.

Extensive data on the distribution and excretion pattern of Sr^{89} in the dog and clinical effects of radiotoxic doses of Sr^{89} , including gross signs and symptoms, rectal temperature, and heart rate, body-weight changes, autopsy findings, hematology, blood chemistry, and plasma protein analysis.

250. TOMIYAMA, T., ISHIO, S., and KOBAYASHI, K. Distribution and excretion of intramuscularly administered Sr^{90} in carp. In *Research in the effects and influences of the nuclear bomb test explosions*, compiled by the Committee for Compilation of Report on Research in the

Effects of Radioactivity, v. 1, p. 1189–1193. Tokyo, Japan Society for the Promotion of Science, 1956.

251. TUTT, M., and VAUGHAN, J. Metabolism of radioactive strontium in the rabbit. *Biochem. Jour.* 44: 35. 1949.

"Rabbits on a diet giving 3–5 g. of Ca in a 9-day period were given a mixture of Sr^{89} and Sr^{90} intravenously as strontium chloride in normal saline, with and without added stable strontium chloride. Sr was estimated in urine and feces from the time of injection until the animals were killed on the ninth day, when the Sr remaining in the body was estimated. Less than 1 percent of the Sr in the carcass existed outside the skeleton. Total retention varied with age; 55 percent in 6-week-olds, 20 percent in 6-month-olds, and 10 percent in older animals. Total excretion varied from 40 percent in 6-week-olds to 70–80 percent in 6-month and older rabbits, reaching a maximum the first 24 hours and a constant low level by the fourth day.

A considerable proportion of the radioactive strontium injected into suckling mothers 1 week after delivery was transferred through the milk to the sucklings, and the percentage retained by the mothers was lower than that retained by nonsuckling animals of the same age. An average of 20 percent was recovered from the litters of 6-month suckling mothers, who themselves retained only 10 percent of the injected dose. On the other hand, only 1–3 percent was recovered from the fetuses of pregnant mothers who were injected 9 days before the expected date of delivery and killed on that day. The percentage retained by the pregnant mothers was not appreciably lower than the average figure for the same age group." (Author's summary.)

252. TYLER, S. A., and GURIAN, J. A comparative study of the time patterns of Sr^{90} excretion characterizing various laboratory animals. U.S. Atomic Energy Comm. ANL-4451, p. 16–21. 1950.

" Sr^{90} excretion data for the dog and goat were used to establish the excretion-time pattern for these laboratory animals. The following empirical fitting processes were employed in determining this relationship: (1) Method of exponentials, (2) log-log regression analysis, (3) modified power fit, and (4) adjusted power fit." (Author's abstract.)

253. VAN DILLA, M. A., STOVER, B. J., and ARNOLD, J. S. On the retention and translocation of radium-224 (Th X) in dogs. *Amer. Jour. Roentgenol., Radium Ther. and Nuclear Med.* 77: 503–510. 1957.

"Chronic Ra poisoning is complicated by the presence of mesothorium (Ra^{228}) and radio-thorium (Th^{228}) and its by-product thorium X (Ra^{224}). Studies in dogs show that Ra^{224} is the principal excretion product and that it is formed from the parent Th^{228} in bone and becomes dispersed over all tissues, thus reducing the radiation concentration hazard." (*Internatl. Abs. Biol. Sci.* 7: 3954.)

254. VISEK, W. J., and others. Determination of endogenous fecal calcium in cattle by a simple isotope-dilution method. *Jour. Nutr.* 50: 23–33. 1953.

R. A. Monroe, E. W. Swanson, and C. L. Comar, joint authors.

"The endogenous fecal Ca of cattle was not significantly changed when the dietary Ca was varied from normal to a high level. In 2 animals on a low-Ca diet a decrease in endogenous fecal Ca was indicated." (*Chem. Abs.* 47: 10081.)

255. WANNER, R. L., and others. Species differences in excretion of intravenously injected calcium 45. *Fed. Proc.* 15: 575–576. 1956.

J. R. Moor, F. Bronner, N. S. Pearson, and R. S. Harris, joint authors.

"The excretion of Ca^{45} in the urine and feces during 5 days after intravenous injection of Ca^{45} was studied in 9 boys (12–15 years), one young man (21 years), 3 adult rhesus monkeys, and 10 albino rats (120 days old). The results of these analyses, together with the results of a

similar study by Maletskos (Ph.D. thesis; Mass. Inst. of Technol., 1955) on 8 adult dogs, are presented below:

Species	Ca ⁴⁵ injected (μc.)	Dose excreted (0-5) days (Percent)	Ratio fecal/urinary Ca ⁴⁵ excreted
Human, boys-----	0.7	8	1:2
Human, adult-----	3.4	20	1:2
Monkey, adults-----	1.7	9	1:2
Rat, adults-----	1.0	14	22:1
Dog, adults-----	1.5	42	10:1

The excretion of intravenously injected Ca⁴⁵ by the rhesus monkey resembles that by human beings; that by rats and dogs is quite different. These data indicate that the endogenous excretion of calcium by human beings and monkeys is similar and unlike that of dogs and rats." (Author's abstract.)

256. WARD, A. H. Retention and excretion of radiostrontium in monkeys. *Jour. Nuclear Energy* 5: 192-202. 1957.

"Single injections of Sr⁹⁰ from 3 μc/kg to 2 mc/kg body weight have been made in a colony of eighty monkeys kept under natural conditions in the tropics. Radioactivity measurements of excretion and retention over a 3-year period are presented, and the relatively slow rate of excretion is analyzed for twenty-eight monkeys. The variation of percentage excretion and retention with injection-dose is shown, and a comparison made with excretion of radiostrontium by other animals and of radium by man." (Nuclear Sci. Abs. 11: 11881.)

257. WARD, A. H. Comparison of excretion and retention of strontium-90 in monkeys and radium in man. *Amer. Jour. Roentgenol., Radium Ther. and Nuclear Med.* 79: 530-531. 1958.

"The Sr⁹⁰ retention curve is calcd. numerically from the summed excretion, and is confirmed by a few Bremsstrahlung and postmortem counting results. The much greater retention of radiostrontium by monkeys compared to Ra by man is clear. The coeff. of elimination, defined as the fraction of the retained Sr⁹⁰ excreted per day, is also plotted, as it levels out after about 100 days, as compared to the const. slope (-1) of the Ra coeff. of elimination. The Sr⁹⁰ coeff. of elimination tends to a const. value of about 0.13% per day, corresponding to an exponential excretion curve with a const. biol. half-life of excretion of about 1.5 years, about 10% of the expected normal life span of these animals." (Chem. Abs. 52: 9405.)

258. WILLIAMSON, B. J., and FREEMAN, S. Effects of acute changes in acid-base balance on renal calcium excretion in dogs. *Amer. Jour. Physiol.* 191: 384-387. 1957.

"Respiratory acidosis, metabolic acidosis, metabolic alkalosis, and compensated metabolic alkalosis were produced experimentally. Addnl. expts. were carried out in normal and alkalotic animals subjected to Ca loading. Ca reabsorption varied directly with filtered load of Ca. The increased excretion of Ca in acidosis appears to be due to an increase in filtered Ca. Reabsorption of filtered Ca was 98-99% in normal and acidotic dogs, but decreased to approx. 90% in dogs made acutely acidotic. The relative loss of water to Ca in the urine in acute alkalosis was decreased, resulting in an elevated renal threshold of retention of Ca in metabolic alkalosis. Elevated CO₂ tension was assoc. with phosphate mobilization from the tissues regardless of whether the CO₂ excess was compensated for by extra alkali." (Chem. Abs. 52: 4795.)

METABOLISM OF STRONTIUM AND CALCIUM IN SPECIFIC TISSUES OTHER THAN THE BONE

259. ARAKI, M., YONEZAWA, T., and SUGA, K. Investigation of calcium metabolism of Yoshida sarcoma

and ascitic hepatoma with the aid of Ca⁴⁵. *Gann* 45: 133-134. 1954.

260. CARR, C. W. Studies on the binding of small ions in protein solutions with the use of membrane electrodes. II. The binding of calcium ions in solutions of bovine serum albumin. *Arch. Biochem. and Biophys.* 43: 147-156. 1953.

"Sulfonated polystyrene-collodion membranes were used to study the binding of Ca to bovine serum albumin in solns. of CaCl₂. A max. of 8 Ca ions per albumin mol. is bound at pH 7.4. Increasing pH favors increased binding. The binding of chloride ion is the same as in the presence of NaCl. The binding of Ca ion to proteins has no effect on the binding of the accompanying chloride ion." (Chem. Abs. 47: 8793.)

261. CATCHPOLE, H. R., JOSEPH, N. R., and ENGEL, M. B. Homeostasis of connective tissue. III. Magnesium-sodium equilibrium and interactions with strontium and lead. *Amer. Med. Assoc. Arch. Path.* 61: 503-511. 1956.

"Diln. potentials with 0.1 isotonic saline were measured before and after equilibration of rabbit connective tissue with isotonic saline contg. low concns. of Mg, Sr, or Pb, and the difference was a measure of the bivalent cation bound to the tissue colloid. Free energies of formation of metal-colloid complexes were calcd. to be -2700 cal. for Mg, -2900 cal. for Sr, and -3500 cal. for Pb. Thus the foreign cations would tend to displace the native ones, and the implications of this are discussed." (Chem. Abs. 50: 15889.)

262. CHOJNACKI, T. Calcium and magnesium level in cerebrospinal fluid. *Polon. Acad. des Sci. Bul.* 4: 337-339. 1956.

"The c.s.f. of children, either with or cured of, tubercular meningitis, shows a relationship between protein and Ca content, the Ca complying with Donnan's equilibrium principle. The Mg is not related to the protein content. Its high concentration in cerebrum, spine and nerves suggests that it passes from nerve tissue directly into the c.s.f." (Internatl. Abs. Biol. Sci. 7: 608.)

263. COURVOISIER, B., BONARD, E. C., and MARTIN, E. Complex salts of calcium and their effects on blood and urine calcium. *Schweiz. Med. Wehnschr.* 84: 1289-1292. 1954.

264. DANIL'CHENKO, O. P. Marking worms (Enchytraeus) with radioactive strontium. *Rybnoe Khoz.* 33 (6): 78-80. 1957.

"Worms do not deposit Sr permanently in their tissues." (Chem. Abs. 52: 592.)

265. DREISBACH, R. H. Accumulation of calcium-45 by salivary glands. *Soc. Expt. Biol. and Med. Proc.* 96: 555-558. 1957.

"Ca⁴⁵Cl₂, 10 μc., was given to ether-anesthetized 6-month-old virgin female Long-Evans rats by injection into a foot vein. Ca⁴⁵ accumulation and loss in the submaxillary gland was much slower than in the kidney. Equil. between gland and blood was reached approx. 4 hrs. after the injection; at 8 hrs. the specific activity in the blood and kidneys had fallen to less than half of that remaining in the submaxillary gland. Equil. was reached at 18 hrs. In the untreated rats total Ca in the submaxillary gland was 21.6 ± 1.0, in the kidney 4.0 ± 0.1, and in blood 3.66 ± 0.14 meq./kg." (Chem. Abs. 52: 5634.)

266. EICHLER, O., APPEL, I., and RITTER, R. Metabolism of dental germs and dental sacs of dogs, tested with calcium-45. *Hoppe-Seyler's Ztschr. f. Physiol. Chem.* 302: 142-150. 1955.

"Dogs were injected with Ca⁴⁵ and blood obtained by heart puncture. The dental germs were obtained from the dental sacs. The specific activity of Ca in the dental sacs was of the same order of magnitude as that in the ultra-filtrate but less than that in the plasma. The

specific activity of the enamel was equal to that of the surrounding tissue, decreasing towards the centre. The specific activity of the outer layer of dentine was greater than that of plasma. The sudden change in specific activity at the interface is due to the incorporation of Ca^{45} in the crystals. This effect was not observed in the enamel; it is concluded that it has a lower rate of exchange and possibly lower surface permeability" (Internatl. Abs. Biol. Sci. 4: 3210.)

267. GEYER, R. P., and BOWIE, E. Relationship of aerobic phosphorylation to radiocalcium metabolism by liver in vitro. Fed. Proc. 17: 476. 1958.

"A rapid uptake of radiocalcium by rat liver slices occurred aerobically but not anaerobically. Radiocalcium gained aerobically was largely lost upon subsequent anaerobic incubation, whereas that gained either aerobically or anaerobically was not lost upon subsequent incubation at 0°C . in nonradioactive medium. These results indicated that calcium metabolism in liver was intimately geared to enzymatic reactions and perhaps to aerobic phosphorylations. Although organic phosphates do not generally enter cells, how far they penetrate the cell membrane itself is unknown. Since most of the calcium in liver appears to be at the cell surface, added organic phosphates could conceivably influence calcium metabolism. This was found to be the case, for in the presence of adenosine triphosphate (ATP), the anaerobic uptake of calcium equalled or exceeded that found aerobically in the absence of ATP. Dinitrophenol (DNP) abolished this effect. In the presence of DNP the aerobic uptake of radiocalcium was diminished to that found anaerobically, whereas DNP had no influence on anaerobic calcium uptake. Thus it can be concluded that a large portion of the calcium occurring in liver tissue is geared to aerobic phosphorylations." (Author's abstract.)

268. GILBERT, D. L., and FENN, W. O. Calcium equilibrium in muscle. Jour. Gen. Physiol. 40: 393-408. 1957.

"When sartorius muscles from the frog were immersed in Ca^{45} Ringer soln., the surface phase took up Ca^{45} in about 1 min.; the extracellular H_2O space and connective tissue in about 30 min.; and the intracellular space in about 300 min. The percent of total Ca in the whole muscle immersed in Ringer's soln. was as follows: In the surface phase 10; in the extracellular H_2O space 12; in the dry connective tissue 17; in the intracellular space 24; and nonexchangeable Ca^{37} . It appears that there is a Ca pump pushing Ca out of the cell against an electrochem. gradient of about 4 cal./mM of Ca. The max. energy required per hr. to pump Ca out of the cell is only 2 cal./kg. muscle or about 1% of the resting energy." (Chem. Abs. 51: 5955.)

269. GREENBERG, D. M. The interaction between the alkali earth cations, particularly calcium and proteins. Adv. in Protein Chem. 1:121-151. 1944.

Discussion of physicochemical aspects of alkaline earth and protein binding.

270. HARRIS, E. J. Output of Ca^{45} from frog muscle. Biochim. et Biophys. Acta 23: 80-87. 1957.

" Ca^{45} was used in the study of Ca turnover in frog muscle. Ca was detd. by titration with ethylenediamine-tetraacetate in a spectrophotometer cell, and rapid comparison between the transmissions through the titration soln. and a standard was possible. This compensated for the decompn. of the murexide indicator. Sartorius muscle kept for 16 hrs. in soln. contg. $\text{Ca}^{45}\text{Cl}_2$ showed only a 10-25% exchange of Ca. The time course of the loss of tracer Ca to a tracer-free soln. was complex. A rapidly lost fraction, partly extracellular in origin, was not clearly separable from the total output. After 1-2 hrs. low rates were observed. These were variable, attributed to part of the isotope becoming incorporated in a relatively in-exchangeable condition. The rate of loss of Ca^{45} was reduced after a delay of 10-20 min. when the tissue was cooled. The rate sometimes was increased when Ca was

omitted from the bathing soln. Stimulation of the muscle did not affect output. Tracer applied to a point on the muscle was but slightly carried along the tissue by an elec. current. The results indicated that muscle Ca is held principally in a bound form, but that the strength of binding is variable." (Chem. Abs. 51: 5244.)

271. HEIN, R. E., and CLEGG, R. E. Exchange and binding of calcium-45 by serum proteins. Jour. Chem. Ed. 33: 320-321. 1956.

272. HIRVONEN, L. Effect of chlorides of alkali and alkali earth metals on the isolated rabbit auricle. Ann. Med. Expt. et Biol. Fenniae [Helsinki] 34 (sup. 1), 26 p. 1956

"Addn. of Li, Na, K, Rb, and Cs chlorides to Locke's soln. surrounding the right auricle prepn. of adult rabbit heart caused a diminution of the R deflection and impaired the mech. activity of the muscle. The duration of the contraction and the relaxation phase was prolonged. Only NaCl shortened the QRS interval. LiCl had no effect while the other chlorides prolonged the QRS wave markedly. Ca, Sr, and BaCl_2 increased the force of contractions. Be and MgCl_2 had a neg. inotropic effect. All alkali earth chlorides except Ca retarded the beating rate. The duration of the isometric contractions was unaffected by Be and MgCl_2 . CaCl_2 prolonged the relaxation phase and Sr and BaCl_2 prolonged both the contraction and relaxation phases. The R wave amplitude was diminished with all alkali metal salts tested. The QRS interval was prolonged by Be, Sr, and BaCl_2 . Mg and CaCl_2 had little effect." (Chem. Abs. 52: 1470.)

273. JOSEPH, N. R. The dissociation constants of organic calcium complexes. Jour. Biol. Chem. 164: 529-541. 1946.

"The interaction of Ca^{++} , Ba^{++} , and Sr^{++} with the anions of citric (I), tartaric (II), succinic (III), phthalic (IV), lactic (V), acetic (VI), salicylic (VII), and benzoic (VIII) acids was studied with electrodes of the third kind ($\text{PbHg}|\text{PbC}_2\text{O}_4, \text{CaC}_2\text{O}_4|\text{Ca}^{++}$) against a $\text{Ag}|\text{AgCl}$ electrode with a satd. KCl bridge. The ionic strength was maintained at 0.15 by varying the amt. of NaCl in the system. From the equations $E = E^\circ + (2.303RT/2F) p\text{Ca}$ and $-\Delta\log [\text{Ca}^{++}] = \Delta p\text{Ca}$, where $p\text{Ca}$ is the neg. log of cation activity, values for $\log K'$ were calcd. In every case it was assumed that the complex formation could be expressed as a reversible bimol. reaction of the type $[\text{M}^{++}] + \text{A}^z = [\text{MA}]^{(2-z)}$, where $[\text{M}^{++}]$ is the metallic cation, A is the activity of the cation, and z is the no. of neg. charges of the acid anion corresponding to the no. of charged carboxyl groups. The values for $\log K'$ were: for Ca, I 3.17, II 1.16, IV 1.07, V 0.82, VI 0.53, VII 0.14, and VIII < 0; for Sr, I 2.92 and II 1.94; for Ba I 2.98, II 1.95, III 0.97, IV 0.92, VII < 0, and VIII < 0. The electrode yielded erroneous results in bicarbonate systems." (Chem. Abs. 40: 6321.)

274. KEPES, A. Potentiometric study of the fixation of alkaline ions and alkaline earths on serum albumin. Acad. des Sci. Paris, Compt. Rend. 239: 117-120. 1954.

"The binding of cations by protein tends to lower the pH of the soln. It has been shown with potentiometric titrations of beef serum albumin in the presence of several salts that the fixation of bivalent ions is stronger than that of univalent ions and that principal site of binding is a functional group with an apparent pK in water of 8.2." (Chem. Abs. 49: 1829.)

275. LEON, M. A. Role of cations in conglutination and in formation of properdin-zymosan complex from bovine serum. Soc. Expt. Biol. and Med. Proc. 96: 202-204. 1957.

"The conglutination of sensitized sheep erythrocytes or zymosan requires Ca^{++} . Mg^{++} and Ba^{++} are inactive; Sr^{++} appears to substitute to a limited extent for Ca^{++} . Zymosan inhibits conglutination of sensitized sheep cells by bovine serum. Bovine properdin and zymosan react readily in the absence of Ca^{++} , but in the presence of Mg^{++} , without any interference due to conglutination." (Chem. Abs. 52: 2960.)

276. MARTELL, A. E., and SCHWARZENBACH, G. Adenosine phosphate and triphosphate as complex-formers for calcium and magnesium. *Helvet. Chim. Acta* 39: 653-661. 1956.

"The stability constants of Ca- and Mg-complexes with adenosine monophosphate, ADP, ATP, and inorg. triphosphate were determined. Adenosine does not bind Ca or Mg. Possible structures of these complexes are discussed." (*Internatl. Abs. Biol. Sci.* 5: 488.)

277. NEUMAN, W. F., and others. Complex ion formation in calcium/bicarbonate system. *Jour. Biol. Chem.* 219: 551-553. 1956.

P. E. Morrow, T. Y. Toribara, L. J. Cassarett, B. J. Mulryan, and H. C. Hodge, joint authors.

"The distribution of Ca between an aq. soln. and a cation exchange resin (Dowex 50) in the presence of HCO_3^- indicated complex ion formation in soln. This was confirmed by an increase in the ultrafilterable Ca of bovine serum at elevated HCO_3^- concn. The complex ion (probably CaHCO_3) is so highly dissociated that an insignificant fraction of serum Ca must be bound to HCO_3^- under physiological conditions. (*Internatl. Abs. Biol. Sci.* 5: 487.)

278. NIEDERGERKE, R., and HARRIS, E. J. Accumulation of calcium (or strontium) under conditions of increasing contractility. *Nature* 179: 1068-1069. 1957.

"The rate of movement of Ca between strips of frog's ventricle and the immersion fluid has been detd. using tracer Ca^{45} or Sr^{89} . Replacement of NaCl by sucrose, LiCl, choline chloride, or tris results in an increased uptake of Sr^{89} . Immersion in K-rich fluid causes a drop in Sr^{89} uptake. The results indicate that replacement of Na ions or omission of K ions in immersion fluids causes the heart tissue to accumulate Ca. It is assumed that Sr and Ca are identical in their behavior." (*Chem. Abs.* 51: 14054.)

279. NIEDERGERKE, R., and LUTTGAU, H. C. Calcium and the contraction of the heart. Antagonism between calcium and sodium ions. *Nature* 179: 1066-1067. 1957.

"The isometric peak tension of the frog's ventricle depends on the quotient ($\text{Ca}^{++}/\text{Na}^+$), rather than on the absolute concns. of either cation. It is suggested that Ca and Na ions compete for an anionic group R located on the cell surface. Replacing NaCl with chlorides of Li, choline, or tris(hydroxymethyl) aminomethane (tris) causes an increase in the tension at low Ca concns. Similar competition between Ca and Na is observed in tensions developed when the excitable membrane of the cell has been depolarized by the application of K-rich solns. Replacing NaCl by sucrose results in a marked increase in tension. NaCl does not alter the degree of depolarization of the cell membrane; therefore it is not an alteration of the membrane potential which causes the tension to change by varying Na concns." (*Chem. Abs.* 51:14054.)

280. ODELL, T. T., JR., and UPTON, A. C. Distribution of calcium-45 in platelets and bone marrow of rats. *Acta Haematol. [Basel]* 14: 291-293. 1955.

"The bone marrow and platelets of rats injected i.v. with Ca^{45} were studied for radioactivity during the 10-day period following injection. Neither platelets or any of the cells of the bone marrow were found to accumulate Ca^{45} . This indicates that there is a free movement of Ca into and out of the platelets, as opposed to the gradual uptake of C^{14} formate for $\text{Na}_2\text{S}_{35}\text{O}_4$." (*Internatl. Abs. Biol. Sci.* 4: 4757.)

281. PAUPE, J. Comparison of the calcium fractions of cerebrospinal fluid and normal blood serum in man. *Soc. de Biol. [Paris] Compt. Rend.* 151: 318-320. 1957.

"In normal human subjects the total Ca of spinal fluid varies independently of the total Ca of the blood serum, but is always slightly higher than the diffusible Ca fraction of the serum." (*Chem. Abs.* 52: 2205.)

82. PRASAD, A. S., BROWN, E. B., JR., and FLINK, E. B. Plasma ultrafilterable calcium in respiratory alkalosis and acidosis. *Amer. Jour. Physiol.* 190: 459-461, 1957.

"Dogs were subjected to either 30 min. of respiratory alkalosis produced by overventilating with a pos. pressure pump, or to 30 min. of respiratory acidosis produced by inhalation of 30% CO_2 in O_2 . Total plasma Ca concn. and ultrafilterable Ca concns. were detd. on arterial blood samples drawn before, during, and after the exptl. procedure. Ultrafilterable Ca concn. decreased slightly during hyperventilation and increased during respiratory acidosis. A rebound increase in ultrafilterable Ca concn. in the recovery phase following hyperventilation and a similar but inverse rebound following respiratory acidosis was observed in every case. Total proteins and fractionated proteins did not show consistent changes which would account for the changes observed in the unfilterable Ca concn. The significant changes in ultrafilterable Ca concn. observed would not be apparent if only total Ca were detd. since total plasma Ca changed very little or not at all." (*Chem. Abs.* 52: 3120.)

283. SCHUBERT, J. Ion exchange studies of complex ions as a function of temperature, ionic strength, and presence of formaldehyde. *Jour. Phys. Chem.* 56: 113-118. 1952.

"The formation const., k_f , of the complex ion $(\text{MA}_n)_c$, where M is Sr^{++} or Ca^{++} , A is an anion, n is the no. of mols. of A relative to M, and c is the net charge of the complex, is related to the equil. ion-exchange formulation. Equilibrating Dowex 50 with the M and the listed ligands (I), at $\text{pH}=7.2-7.3$, $\mu=0.16$, and $t=25^\circ$, and measuring the amt. of M in the resin and liquid phases showed that the M forms 1:1 complexes with the I.

Ligand	Ligand concn. (moles/l)	k_f with no HCHO	k_f with 10% HCHO
aspartic acid.....	0.015-0.12	2.8 ± 0.7	7 ± 2
butylamine.....	0.02-0.07	14 ± 2	14 ± 2
ethanolamine.....	0.02-0.07	9.2 ± 0.8	12.8 ± 1
succinic acid.....	0.005-0.04	9 ± 1	8 ± 2
malic acid.....	0.004-0.04	116 ± 8	27.9 ± 1.4
HCHO.....	2.3-6.9	0.02	0.02
citric acid.....	0.0016-0.0040	-----	647 ± 12

In the temp. range $3-40^\circ$ at const. μ , k_f of the Sr citrate complex is const., whereas decreasing μ increases its k_f . The presence of 10% HCHO (II) had a great effect on the affinity of aspartic acid (III) for the M, as shown. This occurs because II increases the acid ionization const. of the amino group (IV) in III, and at the same time reacts with the uncharged IV. The net result is an increase in the bound fraction of M. Since the resulting k_f is roughly equiv. to that of the malate anion (V), it appears that the group formed on the IV between II and $-\text{NH}_2$ exerts a complex-forming action similar to that of the $-\text{OH}$ group in the V." (*Chem. Abs.* 46: 7400.)

284. SCHUBERT, J. Complexes of alkaline earth cations including radium with amino acids and related compounds. *Amer. Chem. Soc. Jour.* 76: 3442-3444. 1954.

"Mass-action consts. for the reaction $\text{M} + \text{A} \rightleftharpoons \text{MA}$, where M is an alk. earth cation and A is an amino acid or related compd. (adenylic acid (3'-phosphate), asparagine, catecholdisulfonic acid, choline, citric acid, creatine, creatinine, cytidylic acid (3'-phosphate), glutamic acid, glutamine, glutathione, hydroxyproline, imidazole, malic acid, methionine, salicylic acid, serine, succinic acid, and tartaric acid) have been measured by the ion-exchange

technique. The stability of these complexes and their application to chromatography is discussed." (Chem. Abs. 48: 13517.)

285. SCHUBERT, J., and CONN, E. E. Radio-colloidal behavior of some fission products. *Nucleonics* 4 (6): 2-11. 1949.

"Under certain conditions radioactive elements in tracer quantities may behave as colloids. When this occurs, it is difficult to obtain reproducible results. In a soln. of $\text{UO}_2(\text{NO}_3)_2$ at its natural pH, contg. most of the fission products, only Zr and Cb do not dialyze completely. Tables are given for the effect of HNO_3 , H_2SO_4 , Na_2SO_4 , and NaNO_3 (each 0.5 M) on the amt. of Zr^{95} and Cb^{95} dialyzed at 50°, and the effect of 0.01 M HCl, 1.0 M HNO_3 , 0.1 M H_3PO_4 , 0.1 M H_2SiF_6 , and 0.1 M oxalic acid on the amt. of Zr^{95} , Cb^{95} , and La^{140} , dialyzed at 25°. The diffusion coeffs. of carrier-free Ba^{140} , Sr^{90} , La^{140} , Zr^{95} , Cb^{95} , Ru^{103} , and Te^{132} in various concns. of $\text{UO}_2(\text{NO}_3)_2$, and H_2SO_4 are tabulated. Means for either inducing or preventing radiocolloidal behavior are discussed. 29 references." (Chem. Abs. 43: 7814.)

286. SCHUBERT, J., and LINDENBAUM, A. Stability of alkaline earth-organic acid complexes measured by ion exchange. *Amer. Chem. Soc. Jour.* 74: 3529-3532. 1952.

"The formation consts. for the complex ions formed between Ca^{++} or Sr^{++} and a series of org. acids are detd. in barbital-buffered solns. at pH 7.2-7.3, ionic strength 0.16, and temp. 25° by utilizing the equil. ion exchange on Dowex-50 resin of essentially carrier-free levels of radioactive cations. All complexes are of the 1:1 type. The logarithm of the formation consts. at 25° between the org. anion from the parent acid listed and Ca^{++} and Sr^{++} , resp., are (nos. in parentheses are approx.): Acetic, (0.62), (0.10); gluconic, 1.22, 1.01; glycine, (0), (0.6); lactic, (0.8), (0.5); pyruvic, (0.8), (0.5); aspartic, 0.44, 0.9; citraconic, 1.3, 1.3; fumaric, (0.48), (0.54); glutaric, (0.55), (0.6); itaconic, 1.2, 0.96; α -ketoglutaric, 1.29, 1.14; maleic, 1.1, 1.1; malic (0.005-0.04M), 2.06, 1.45; malic (0.004-0.04M), —, 1.42; malonic, 1.36, 1.27; oxalacetic at 3°, 1.60, —; succinic, 1, 0.9; tartaric, 1.78, 1.59; transaconitic, 1.50, 1.51; α -carboxypimelic, 1.59, 1.54; citric (0.0002-0.004M), 3.15, 2.82; citric (0.0008-0.002M), 3.16, 2.88; isocitric, 2.47, 2.02; oxalosuccinic, (1.5), —; tricarballic, 1.82, 1.68; ascorbic, (0.19), (0.35); diethylbarbituric, (0.66), (0.48)." (Chem. Abs. 46: 11005.)

287. SCHWARZENBACH, G., and ANDEREGG, G. The alkaline earth complexes of adenosinetetraphosphate, glycerophosphate, and fructosephosphate. *Helvet. Chim. Acta* 40: 1229-1231. 1957.

"The stability consts. of the Ca and Mg complexes has been detd. The similarity of values for glycerophosphate, fructophosphate and adenosinemonophosphate complexes lends support to the concept that the metal ion is held only through the phosphate group and that the adenine residue does not participate. The Mg complex of adenosinetetraphosphate is only a little more stable than that of adenosinetriphosphate although there is considerable increase in the stability from the monophosphate to the diphosphate and from the diphosphate to the triphosphate." (Chem. Abs. 51: 18026.)

METABOLISM OF STRONTIUM AND CALCIUM IN HARD TISSUES

METABOLISM AND DEPOSITION OF STRONTIUM AND CALCIUM IN THE SKELETON

Deposition of Strontium and Calcium in the Skeleton

292. AMPRINO, R. Observations on the fixation *in vitro* of uranium to sections of bone. *Experientia* 9: 291-293. 1953.

288. SMITH, R. M., and ALBERTY, R. A. Apparent stability constants of ionic complexes of various adenosine phosphates with divalent cations. *Amer. Chem. Soc. Jour.* 78: 2376-2380. 1956.

"Equations have been derived for the calculation from pH measurements of apparent stability constants of complexes for cases in which more than one complex may be formed. The formation of complexes of adenosine-5-mono, di and triphosphate, orthophosphate and creatine phosphate with Ca^{++} , Mg^{++} , Sr^{++} and Mn^{++} has been studied at 0.2 ionic strength and 25°. The relative values of the stability constants are in the order expected from electrostatic theory; $\text{ATP}^{-4} > \text{ADP}^{-3} > \text{P}^{-2}$, AMP^{-2} and $\text{ATP}^{-3} > \text{ADP}^{-2}$ and $\text{Mg}^{++} > \text{Ca}^{++} > \text{Sr}^{++}$. The ionization constants of the complexes of ATP and ADP with Ca^{++} , Mg^{++} , Sr^{++} and Mn^{++} have been calculated." (Chem. Abs. 50: 13119.)

289. STANGLE, E. Problem of calcium metabolism and calcium therapy. *Praxis [Bern]* 46: 41-44. 1957.

290. VAN OS, G. A. J., and KOOPMAN-VAN EUPEN, J. H. M. The interaction of sodium, potassium, calcium, and magnesium with human serum albumin, studied by means of conductivity measurements. *Rec. des Trav. Chim. des Pays-Bas* 76: 390-400. 1957.

"This investigation was carried out to test the usefulness of cond. measurements in the study of protein-ion interactions. The use and standardization of the cond. cell are described. Measurements were performed with albumin (I) solns. which were defined by a const. neg. net charge of 36 units per mol. of I, corresponding to a mean pH of 7.5. These solns. were prepd. from a stock isoionic soln. of I electrodiluted until no Na or Ca could be detected. Na albuminate (II) and K albuminate (III) prepd. by addn. of NaOH and KOH, resp., were titrated with both NaNO_3 and KNO_3 . Little or no binding of Na and K by I was observed. Conductivities of these solns. indicate that II and III behave as fully dissoed. electrolytes. However, Ca and Mg are bound by I (about 8 ions of either Ca or Mg per mol. I). When both ions are present, competition for binding will occur. The no. of ions bound corresponds to only a fraction of the net initial charge. This method of study can be used when only small amts. of protein are available." (Chem. Abs. 51: 14854.)

291. WELLER, H. Calcium uptake in homogenized organs from immature, adult and aging rats. *Jour. Cell. and Compar. Physiol.* 47: 377-395. 1956.

"Rat heart, psoas muscle, kidney, brain, liver, and skin, when homogenized or otherwise comminuted in CaCl_2 soln., will take up an amt. of Ca which is characteristic for each tissue. With a few exceptions the trend proceeds from a high initial activity of the tissues to a general low beginning between the 1st and 5th month of life. The H_2O content of the organs does not vary significantly during the span of 1-28 months and no correlation is found between Ca uptake by a tissue and its H_2O content. Ca reduces the soly. of some components of the homogenates, apparently proteins and nucleic acids. These expts. do not show a significant role for Ca in the senescence of rats but suggest that max. Ca affinity is assocd. with the processes of active growth." (Chem. Abs. 50: 17071.)

"Ground sections, 30-45 μ thick, were treated with 0.1% soln. uranyl nitrate in 0.025N NaHCO_3 buffer. Whole fresh bone, bone fixed in 95% EtOH or formalin, and bone freed of its org. material were also treated. After treatment, sections were washed in distd. H_2O , air-dried, and autoradiographed with C_2 Ilford Nuclear Research plates. The distribution of U was found to be qualitatively identical to that of Ca^{45} and P^{32} . However, the differential uptake in new bone tissue as compared to old is much greater than for Ca^{45} . Removal of org. components from bone ground substance increases the ability of bone tissue to fix U. Distribution of U is uniform throughout sections

freed from org. components. When sections of whole bone are treated first with Ca^{45} and then with U and Ca^{45} , a further fixation of both Ca^{45} and U is demonstrable. Contrary to Ca^{45} , nearly 90% of U deposited in sections of whole bone can be removed by treatment with 0.025N NaHCO_3 . Decalcified sections fix 60-80% as much U as nondecalcified sections." (Chem. Abs. 48: 1570.)

293. ANTONI, R., and CREMER, H. D. Nutrition factors in teeth and bone formation. IV. Uptake and storage of calcium-45 in the organism. Biochem. Ztschr. 326: 311-316. 1955.

"Dispensation of radioactive Ca salts which are given to the rats in 1 g. feed after 8-hr. fasting proved to be a good way of application, in that the salt is taken up swiftly and quantitatively. Improvement of the technique for recovery of samples made it possible to recover the activity introduced within $\pm 5\%$. Reabsorption and storage of Ca could be improved by administration as citrate along with vitamin D. In the molars and bones, the activity reached its max. within 24 hrs.; in the gnawing tooth, however, the activity reached its max. only 3 weeks after the last application of Ca^{45} ." (Chem. Abs. 50: 4320.)

294. ARNOLD, J. S. Calcium metabolism of growing and mature bone. Fed. Proc. 11: 5-6. 1951.

"A radioautographic study of the Ca^{45} distribution in the bones of growing and mature rats and rabbits was made. Animals were given Ca^{45} intravenously in tracer amounts and sacrificed over a period of 3 weeks. Radioautograms were made from 5-10 micron sections of the undecalcified bones. A clear picture of the pattern of bone growth on a histologic scale was demonstrated. Ion-exchange experiments on various areas of bone from the animals were performed. The degree of *in vitro* exchangeability of the Ca^{45} deposited *in vivo* was determined. The relative importance of ion exchange on the surface of bone salt crystals in growing and mature bone was evaluated. Ethylenediamine hydrolysis and extraction of bones gave information about the relative amount of Ca^{45} combined with the organic matrix at various time intervals after deposition." (Author's abstract.)

295. ARNOLD, J. S., and JEE, W. S. S. Double tracer radioautographic studies of Ca^{45} and Ra^{226} bone deposition. Radiation Res. 1: 488. 1954.

"In order to study the degree to which radium follows the metabolic pathways of calcium, a slowly growing rabbit and a 5-month-old beagle puppy were given single intravenous injections of a mixture of Ca^{45} and Ra^{226} as the chloride and sacrificed at 24 hours. Detailed radioautographic studies of 5- μ bone sections revealed that there was a complete qualitative similarity of the topical depositions of radium and calcium in areas of mature and forming bone. Ra^{226} and Ca^{45} were separately detected by counting α -tracks and individual silver grains in NTB emulsion. In contact radioautograms the ratio of α -tracks to individual silver grains was found to be lower in areas of mature bone than in areas of forming bone by a factor of 0.5 to 0.2. When radioautographically distinguished mature and forming bone were separately analyzed for Ra^{226} and Ca^{45} (B. J. Stover and J. S. Arnold, 1954), the ratio of the former to the latter was found to be lower in areas of mature bone than in forming bone by a factor of only 0.8. The discrepancy between radioautographic and analytical data is interpreted as being due to relatively greater *in vitro* radon escape from mature bone." (Author's abstract.)

296. ARNOLD, J. S., JEE, W. S. S., and JOHNSON, K. Observations and quantitative radioautographic studies of calcium 45 deposited *in vivo* in forming Haversian systems and old bone of rabbit. Amer. Jour. Anat. 99: 291-314. 1956.

"A quant. radioautographic study was made of the relative isotopic concn. in forming bone of secondary Haversian systems (osteone) and older primary cortical bone of tibias of slowly growing rabbits by using 4 rabbits given 0.5 mc./kg. of Ca^{45} intravenously and sacrificed at 1 and 24 hrs. and 1 and 3 weeks later. Corresponding ground sec-

tions were made for each radioautogram. Ca^{45} -conc. Haversian systems were normally distributed with respect to ability to conc. Ca^{45} at each sacrifice time. Uptake of Ca^{45} in old primary bone was relatively uniform, whereas forming Haversian systems showed an avidity for Ca^{45} up to 10 times that of old bone. However, variations in avidity were such as to suggest a normal frequency distribution with respect to avidity. Av. concn. of Ca^{45} in new bone of forming Haversian systems was 5 times greater than in old bone. The ratio of Ca^{45} in new to old bone, and the concn. of Ca^{45} forming bone, both increased during the 24 hrs. following administration; no further changes occurred thereafter. No change in Ca^{45} concn. was noted in old bone throughout the 3 weeks. The data are interpreted as indicating that Ca^{45} fixation in old bone is rapid and irreversible during the 3-week period studied. Intense Ca^{45} concn. in forming Haversian systems is limited to a few rapidly calcifying lamellae and is not uniformly distributed. Ca^{45} concn. in bone formed shortly prior to or after Ca^{45} administration is 1.5-2 times that of old bone." (Chem. Abs. 51: 14948.)

297. ARNOLD, J. S., JOHNSON, K., and JEE, W. S. S. Quantitative radioautographic study of the concentration of *in vivo*, fixed Ca^{45} in new and mature bone. Fed. Proc. 13: 421. 1954.

"This study was designed to measure directly the relative Ca^{45} concentrations in newly formed and mature bone as a function of time after isotope administration. Four 6-pound rabbits were given 1 mc./kg. of Ca^{45} i.v. and sacrificed at 1 hour, 24 hours, 7 days, and 21 days. Contact radioautograms of thin ground cross sections of the tibial shafts were analyzed with a microdensitometer. A linear dose-response relationship for Ca^{45} beta rays was established for the radioautographic procedure. Density measurements were made in areas of the autograms corresponding to mature bone and bone which was forming at the time of Ca^{45} administration. The data are expressed as the ratio of Ca^{45} concentration in newly formed to that of adjacent mature bone with respect to individual forming Haversian systems. The results of these studies may be summarized as follows: (1) There was no change in the ratio between 24 hours and 3 weeks after Ca^{45} administration. (2) In all animals the frequency distribution of the ratios found at all levels of the tibial shaft were bell shaped. (3) The average ratio in the 24-hour sacrificed animal was 4.0, whereas that of the other sacrifice intervals was between 5.5 and 6.0. These studies indicate that the concentration of Ca^{45} incorporated in mature bone is quite stable after initial fixation and does not correspond to a labile form of bone calcium as previously speculated. This strongly indicates that recrystallization *in vivo* must be occurring in mature bone at an extremely rapid rate, producing a relatively irreversible fixation of crystal surface calcium." (Author's abstract.)

298. ARNOLD, J. S., STOVER, B. J., and VAN DILLA, M. A. Failure of Y^{90} to escape from skeletally-fixed Sr^{90} . Soc. Expt. Biol. and Med. Proc. 90: 260-263. 1955.

"The data presented show that Y^{90} produced *in vivo* from long-term skeletal deposits of Sr^{90} in young dogs does not escape from the local areas of bone in which it is produced. The implications of this finding are: (1) the combined energy of the Sr^{90} and Y^{90} irradiates the skeleton, hence dosimetric data detd. *in vitro* can be directly applied to *in vivo* conditions. (2) The Sr^{90} deposited in the growing skeleton is probably intracryst. (This is in agreement with the x-ray diffraction findings of other investigators.)" (Chem. Abs. 50: 2700.)

299. ASLING, C. W., and others. Deposition of radioactive Sr and the rare earths in the skeletal tissue of the rat. Anat. Rec. 103: 420. 1949.

D. Axelrod-Heller, D. H. Copp, and J. G. Hamilton, joint authors.

300. BELANGER, L. F. Autoradiographic visualization of Ca^{45} intake by normal and pathological cartilage

in vitro. Soc. Expt. Biol. and Med. Proc. 88: 150-152. 1955.

"Demineralized sections of normal and pathol. cartilage from various sources were soaked in dil. $\text{Ca}^{45}\text{Cl}_2$ soln., then coated with fluid photographic emulsion. The autoradiographic record showed an apparently specific pattern of Ca^{45} intake. Comparison of these images and those obtained with S^{35} sulfate *in vivo* and also the negating effect of hyaluronidase seem to indicate a relation between Ca^{45} intake and the relative local distribution of sulfated mucopolysaccharides in the tissue." (Chem. Abs. 49: 6434.)

301. CARTIER, P. Affinity of skeleton of the growing rat for radiophosphorus. Acad. des Sci. Paris, Compt. Rend. 241: 1632-1634. 1955.

"Renewal of $\text{Ca}_3(\text{PO}_4)_2$ in bone is the result of 3 reversible phenomena: (1) cellular activity in depositing and resorption of minerals, (2) ionic exchange, and (3) recrystn. These factors vary in importance with the age of the animal. In growing animals, cellular activity plays a greater part than the slow physiochem. phenomena in mineralization of bone. C. measured affinity of the bone for P *in vivo*. Rats were injected with radiophosphorus as NaH_2PO_4 and killed after 24 hrs. The amt. of P and of mineralization activity was detd. in the centrodiaphysar region of femurs. Results show that affinity for P is a function of the degree of mineralization of the bone, and is very elevated in the growth phase, then acquires a low but constant value when mineralization of the skeleton is finished." (Chem. Abs. 50: 6627.)

302. CHAIKOFF, I. L., FISHLER, M. C., and ENTENMAN, C. Radio strontium (Sr^{85}). U.S. Atomic Energy Comm. MDCC-1142-D, 1 p. 1947.

Tracer studies with Sr^{85} show that absorption of this material in the bones of animals receiving it by mouth was found to rise by a factor of almost 2 between the 4th and 16th days.

303. CHAIKOFF, I. L., FISHLER, M. C., and ENTENMAN, C. Radio strontium (Sr^{85}). U.S. Atomic Energy Comm. MDCC-1143-B, 8 p. 1947.

Experiments indicate that intraperitoneal injection of Sr^{85} results in 75 percent deposition in the bones; soft tissues contain negligible quantities; oral administration results in 10 percent uptake in 24 hours.

304. COPP, D. H., AXELROD, D. J., and HAMILTON, J. G. The deposition of radioactive metals in bone as a potential health hazard. Amer. Jour. Roentgenol. and Radium Ther. 58: 10-16. 1947.

Radioactive Sr, Y, Ce, and Pu were used to study the metabolism of bone to determine factors concerned in the absorption and deposition of these elements in the skeleton of rats and the precise sites of localization; radioautographs appended.

305. ENGFELDT, B., and others. Biophysical studies on bone tissue. XIII. A preliminary study of the *in vivo* and *in vitro* uptake of strontium in bone tissue and the osseous localization of radioactive fission products from atomic explosions. Acta Orthop. Scand. 24: 101-114. 1954.

H. Björnerstedt, C. J. Clemenson, and A. Engstrom, joint authors.

"*In vivo* and *in vitro*, the uptake of Sr^{90} is rapid in dogs and follows the pattern established for P, Ca, and SO_4^{--} . Almost immediately after an at. explosion bone-seeking isotopes are formed which may be hazardous to health for at least as long as a human lifetime." (Chem. Abs. 49: 16152.)

306. FLOYD, R. L., TAYSUM, D. H., and VAN DILLA, M. A. Strontium retention and bone metabolism experiments, II. Utah Univ. Radiobiol. Lab. Ann. Prog. Rpt. 89: 106. 1956.

A continuation of studies on strontium retention and bone metabolism reported previously (Ann. Prog. Rpt.,

Mar. 31, 1955), in which the measurements of Sr retention and avidity of the skeletons of dogs on plutonium for strontium as a function of skeletal irradiation are discussed. Conclusions drawn are that the range of Y^{90} β -rays is comparable to the thickness of many bones of a beagle's skeleton. Strontium retention may be less than radium retention. A double-tracer experiment using γ -ray spectroscopy to follow *in vivo* retention is suggested as a means to settle the question. Skeletal irradiation by α -rays decreases the ability of bone to retain Sr^{85} tracer. The effect is definite 1.5-3.0 years after injection of the α -emitter, and data strongly suggest it may occur as early as 3 months after injection.

307. HAMILTON, J. G. Tracer studies of fission product metabolism. U.S. Atomic Energy Comm. MDCC-1062, 8 p. 1945.

Experiments on rats with carrier-free fission products indicate that the alkaline earths, rare earths, and Zr, Np, and Cb are deposited primarily in the skeleton and are eliminated at rates lower than their radioactive decay rates. The radioelements Ru, Te, Xe, I, and Cs show no very striking deposition in any tissue other than the deposition of I in the thyroid and, with the exception of I, are eliminated at a greater rate than they decay.

308. HAMILTON, J. G. The metabolism of fission products and the heaviest elements in rats and plants. Radiology 49: 325-343. 1947.

"All radioactive elements that accumulate in bone with the exception of Sr are not deposited in the mineral structure of bone, but are localized in and adjacent to the osteoid matrix. The large fraction of La, Ce, Pr, 61, Am, and Cm deposited in the liver was an unexpected finding, and it may be predicted that the same will be true for Nd, Sm, and Eu." (Chem. Abs. 42: 232.)

309. HAMILTON, J. G., and others. Deposition of plutonium and certain fission products in bone as a decontamination problem. U.S. Atomic Energy Comm. AECD-2483, 98 p. 1946.

D. H. Copp, D. M. Greenberg, M. J. Chace, L. Van Middlesworth, E. M. Cuthbertson, and D. J. Axelrod, joint authors.

Results of experimental studies in the following chapters: (1) Factors affecting the absorption of radioactive Sr from the gut. (2) Factors affecting the retention of injected radioactive Sr. (3) Effect of age and dietary Ca on radioactive Sr, Y, Ce, and Pu. (4) Effect of treatment on chronic elimination of radioactive Sr, Y, Ce, and Pu. (5) Uptake of radioactive Sr, Y, and Pu in healing fracture callus. (6) Effects of severe P deficiency. (7) Bone radioautographs of radioactive Sr, Y, Ce, Zr, and Pu.

310. HOECKER, F. E. The deposition of radioactive substances in bone. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (11): 138-145. 1956.

311. ITO, Y., TSURUFUJI, S., and MURAI, E. Physiological chemistry of the hard tissues. II. Uptake of radioactive calcium from the diet by incisor tooth and bone of rat. Jour. Biochem. 44: 195-203. 1957.

"Young growing male albino rats are fed on the following synthetic diet for Ca-balance expts.: wheat flour 70, purified casein 20, brewers' yeast 5, vegetable oil 5, CaCO_3 1.25, KCl 1.1, NaCl 0.669, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 0.406, $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ 0.0200, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ 0.0943, KI 0.0103, $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ 0.0021, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 0.0012, and distd. water 60, in proportions by wt. (Ca 0.322, P 0.294%). Body wt. growth parallels food intake, while the skeletal bone (I) growth in wt. is not necessarily related either to Ca or food intake. A larger amt. of Ca ingestion causes neg. Ca balance. Av. daily retentions of Ca in one expt. and Ca^{45} in another expt. in total body from the 9th to 11th exptl. days ($\text{Ca}^{45}\text{CO}_3$ is used) are detd. as 36.5 and 51.7 mg., resp., and the av. bone Ca^{40} -body fluid Ca^{45} exchange is calcd. as 15.2 mg./day. Daily Ca deposition (av. 0.62 mg.) in the lower incisor is greater than Ca^{45} retention (av. 0.433 mg.), whereas Ca deposition in I

(av. 36.5 mg.) is smaller than Ca^{45} retention (av. 50.7 mg.)." (Chem. Abs. 51: 12269.)

312. JARABAK, J. R., KAMINS, M. M., and VEHE, K. L. Radioautographic study of the deposition of the calcium 45 in the cranium, teeth and mandible. Amer. Dent. Assoc. Jour. 47: 639-648. 1953.

"As shown by radioautographs, deposition of Ca^{45} is essentially the same in the bones of the cranium and mandible as in long bones. Ca^{45} injected intraperitoneally into rats as CaCl_2 , deposited in greatest abundance in the sutures between the cranial bones, to a lesser extent in their periosteum and endosteum. Deposition in the mandibular condyles corresponded to that in the epiphyses of the long bones. Deposition was greatest in the newly formed dentine and enamel of the continuously growing incisors, less in the coronal dentine, still less in the root dentine, and practically nil in the enamel of the molar teeth." (Chem. Abs. 48: 1510.)

313. JONES, D. C., and COPP, D. H. Studies of bone metabolism with the aid of radioactive strontium. Jour. Biol. Chem. 189: 509-514. 1951.

Study of the kinetics of skeletal uptake and urinary excretion of radiostrontium during the critical first hour after intraperitoneal injection of a carrier-free dose; data concerning the similarity of Sr and Ca and data on the process of calcification.

314. JOWSEY, J., OWEN, M., and VAUGHAN, J. Microradiographs and autoradiographs of cortical bone from monkeys injected with Sr^{90} . Brit. Jour. Expt. Path. 34: 661-667. 1953.

"Microradiographs and autoradiographs were prepd. from the same cross section of cortical bone from the tibia of 2 monkeys injected with Sr^{90} . The uptake of Sr^{90} is very uneven and occurs only in areas of bone growth." (Chem. Abs. 48: 8403.)

315. JOWSEY, J., and others. Deposition of Sr^{90} in rabbit bones following intravenous injection. Brit. Jour. Expt. Path. 34: 384-391. 1953.

B. Rayner, M. Tutt, and J. Vaughan, joint authors. " Sr^{90} distribution and retention were studied in the bones of young rabbits for 18 months after injection. In rabbits injected when 1 day old, the immediate local concn. in areas of active bone growth rapidly disappears, but in animals aged 5-7 weeks when injected, it remains. Secondary deposition, that taken up from the blood and tissues after release from the bone by resorption, is diffuse throughout the bone and accounts for most of the Sr^{90} retained in young animals, and only a small part of that in the older group. Since age seems to det. the location of the main deposits, it may be related to tumor formation." (Chem. Abs. 48: 2903.)

316. KIEHN, C. L., GUTENTAG, J., and GLOVER, D. M. Localization of isotopes in bone grafts by autoradiography. Plastic and Reconstr. Surg. 14: 425-430. 1954.

317. KRASOVSKAIA, S. P. Deposition of mineral phosphates in bone tissue during the "taking" of a bone graft. Byul. Eksper. Biol. i Med. 40: 37-40. 1955.

"After resection of a part of the ulna in an adult rabbit, and replacement of the defect by autotransplantation there is a reaction on the part of the graft, and the severed portions of the operated bone, whereby a sharp rise in the rate of phosphate deposition occurs. In the bone residue the max. deposition is seen about the 7th-12th day; it slows down until about the 30th day, and then again increases to 1.5 months. In the graft the deposition of phosphate increases gradually, and at the end of 1.5 months its rate of deposition is 10-12 times that in the diaphysis of a normal bone. After 1.5 months the rate of deposition of phosphates in the transplant and in the severed portions of the operated bone gradually falls. These changes in the metabolism of inorg. phosphate correspond to the morphological changes taking place

during transplantation. Analysis of other long bones of the operated animals showed analogous movements of mineral metabolism. The "taking" of a bone graft represents a process going forward in the whole skeleton." [Russian.] (Internatl. Abs. Biol. Sci. 7: 3430.)

318. LACROIX, P., DEVIS, R., and SCHICKS, E. Distribution of radiophosphorus in the long bones of adult rabbits. Experientia 8: 113-114. 1952.

"Three fully grown rabbits were injected subcutaneously with carrier-free P^{32} in physiol. saline at pH7. The rabbit sacrificed in 6 days received 2 mc. in 2 days; the other 2 received 4 mc. in 3 days. Even at 76 days the specific activities of the epiphyses of the long bones were markedly higher than those of the diaphyses." (Chem. Abs. 46: 7204.)

319. MacDONALD, N. S., and others. The ultimate site of skeletal deposition of strontium and lead. Jour. Biol. Chem. 189: 387-399. 1951.

F. Ezmirlian, P. Spain, and C. McArthur, joint authors. "X-ray diffraction studies of bone ash of rats receiving repeated injections of SrCl_2 and of $\text{Pb}(\text{OA})_2$ indicate that both of these cations ultimately enter into the internal structure of the inorg. crystallites. Powder patterns made with the Debye camera showed no evidence of a second solid phase, even in bone samples contg. as much as 8% Sr or 5% Pb. The unit cell dimensions of such bones laden with Sr or Pb were detd. with a precision of $\pm 1\%$ by use of a sym. focusing back reflection camera. Cohen's method (C.A. 30, 7945) was used for extrapolation of the data to a Bragg angle of 90° . These detns. clearly demonstrated distortions of the unit cell as a result of the presence of the foreign ions. It was impossible to ascertain by d. detns. whether the foreign cations were present in the lattice interstices or had taken up lattice-point positions by displacing the normal ionic occupants of those positions. Large ectopic calcifications were noted on the peritoneal surfaces of the rats receiving intraperitoneal injections of $\text{Pb}(\text{OA})_2$. The ash of this material showed the same cryst. structure as bone salt, except that the lattice was distorted by the presence of Pb. Although the evidence sheds little light on the initial phases by which Sr and Pb ions are accumulated in bone, it is concluded that some, and perhaps most, of the cations ultimately become part of the cryst. structure of the bone salt. The length of time during which such material remains fixed depends upon the rate of bone resorption and reformation." (Chem. Abs. 45: 5283.)

320. MacDONALD, N. S., and others. Mechanisms in skeletal accumulation of ions. Arch. Biochem. and Biophys. 43: 118-126. 1953.

R. E. Nusbaum, F. Ezmirlian, R. C. Barbera, P. Spain, and D. E. Rounds, joint authors.

"A single injection of Sr (0.10-75.00 mg./200 g. body wt.) or Pb (0.03-6.00 mg./200 g.) was administered to rats and the content of metal in the femur detd. after 24 hrs. The uptake indicated that at least 2 modes of accumulation occur. The dominant process at low dosages is described satisfactorily by an equation of the same form as the Langmuir gas adsorption isotherm (C.A. 12, 2152). An abrupt discontinuity in the graph appeared as the dosage was increased. This departure from linearity was interpreted as the point where satn. of the initial mode of deposition was reached. The values of these satn. levels for Sr and Pb were 125 and 60 p.p.m., resp. It was estd. that if the 1st-stage satn. were the result of adsorption or ionic exchange at surfaces of bone crystals, the av. burden would be approx. 32 atoms of Sr per crystal and 6 in the case of Pb. The combining power of the sulfate present in the org. matrix of bone could equally well account for the binding of the satn. levels of Sr and Pb." (Chem. Abs. 47: 9467.)

321. MacDONALD, N. S., and others. The skeletal deposition of nonradioactive strontium. Jour. Biol. Chem. 188: 137-143. 1951.

R. E. Nusbaum, R. Stearns, F. Ezmirlian, and P. Spain, joint authors.

"1. The chronic toxic effects of strontium lactate in the drinking water of growing mice are described. The data on the amounts of Ca and Sr in the femurs indicate that Sr actively inhibits calcification *in vivo*, even though the solid diet is adequate with respect to calcium, phosphorus, and vitamins A and D. The same effect is shown by growing rats receiving intraperitoneal injections of SrCl_2 every 48 hours. However, as much as 7 percent of the inorganic content of the bones may be Sr without gross evidence of rickets.

2. The data on Ca:Sr ratios are interpreted as indicating the operation of two distinct modes of Sr deposition in the bone. The first very rapid phase is attributed to removal of Sr^{++} from the blood by surface adsorption, ionic exchange with bone Ca^{++} , binding of Sr^{++} by preosteoid protein, or combinations of these. For young mice, less than 20 mg. of ingested Sr saturates this mechanism. For young rats receiving intraperitoneal injections of SrCl_2 , the Ca:Sr ratio drops very sharply to 50:1. For mature rats this critical value is 150:1. Strontium in excess of the amounts necessary to produce these levels is accumulated at a much slower rate by a second mode of deposition, which presumably involves incorporation of the Sr^{++} into the crystal lattice of the bone salt.

3. A spectrographic method for quantitative simultaneous determination of calcium and strontium in bone ash is described." (Author's summary.)

322. MARSHALL, J. H., ROWLAND, R. E., and JOWSEY, J. Quantitative autoradiographic measurement of calcium-45 concentrations in cortical bone. U.S. Atomic Energy Comm. ANL-5679, p. 48-62. 1957.

"A method has been developed for the evaluation of concentrations of beta-particle activity from thick-section autoradiograms. The method is particularly applicable to the study of short-range beta emitters in bone. A cross-section of bone that is thick to the beta particles is sandwiched between two autoradiographic plates. Only those distributions of activity that produce nearly identical exposure patterns on the two plates are analyzed. The film darkening from these distributions is compared with that from a thick uniform plaster-of-paris radiator with a microdensitometer. Simple relations between the activities and the exposure of uniform, one dimensionally arbitrary, and two dimensionally arbitrary distributions of activity are derived from the postulate that the distribution does not vary with depth within a beta-particle range from the surface of the film. The activity per unit depth for any distribution that satisfies this invariance requirement can be quickly obtained with an accuracy of a few percent. The growth of Haversian systems, periosteal and endosteal surfaces, and diffuse calcification in bone is being studied with this technique." (Author's summary.)

323. NEUMAN, W. F. The use of isotopes in study of skeletal physiology and metabolism. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (11): 134-137. 1956.

324. NORRIS, W. P., and KISIELESKI, W. E. Early distribution of $\text{Sr}^{89,90}$ in rats. U.S. Atomic Energy Comm. ANL-4108, p. 5-12. 1948.

An investigation is described of the early distribution pattern of Sr in order to determine whether qualitative or quantitative differences in metabolism could be detected.

325. POLYAKOV, V. A. Radioautography in study of bone fractures. Vest. Rentgenol. i Radiol. 31: 69-73. 1956.

"Expts. with broken bones in dogs, rabbits, and rats, using P^{32} and Sr^{89} and Ca^{45} tracers showed that concn. of mineral salts at the site begins in 3-5 days. The mineral components are mobilized from the total body supply. The supernormal concn. remains at the site for 12-18 months. The radioisotopes are brought to the site not by diffusion but by the circulating blood." (Chem. Abs. 50: 8839.)

326. RAMFJORD, S., BURGESS, J., and HINIKER, J. J. Radioautographic study of P^{32} and Ca^{45} uptake in jaws and knee joints of adult rats. Oral Surg., Oral Med. and Oral Path. 10: 541-545. 1957.

"The incorporation of i.p. administered P^{32}O_4 and Ca^{45} ions into the jaws and knee joints was studied by radioautography of thin ground sections. The relative uptake of the radioisotopes in the various tissues after periods of 12 hr. and 6 days (both groups) and 59 days (Ca^{45} group) from injection are described and illustrated. A basically similar distribution of the isotopes was observed, with a limited penetration of calcified tissues, increasing with time. The periodontal membrane showed a much greater uptake than the periosteal tissues, and marked variation of uptake between different parts. The significance of ionic exchange in isotope incorporation by calcified tissues is discussed." (Internatl. Abs. Biol. Sci. 8: 204.)

327. RAY, R. D., and others. Studies of bone metabolism—I. Comparison of the metabolism of Sr^{90} in living and dead bone. Jour. Bone and Joint Surg. 37A: 143-155. 1955.

D. LaViolette, H. D. Buckley, and R. S. Mosiman, joint authors.

"It is concluded that viability of the bone cells is not essential in the process of inorganic salt uptake by bone, provided the organic matrix is present and normal. The term 'uptake,' as used in this report, includes several possible processes: Ionic exchange, recrystallization, and the formation of new crystals either in the old matrix or in conjunction with the formation of a new matrix. Mobilization of the inorganic salts from bone, on the other hand, is facilitated by the presence of living cells. A corollary of these conclusions is that uptake of radioactive isotopes is probably not an accurate index of bone-cell 'viability'." (Author's summary.)

328. ROBISON, R., LAW, K. A. O'D., and ROSENHEIM, A. H. Deposition of strontium salts in hypertrophic cartilage *in vitro*. Biochem. Jour. 30: 66-68. 1936.

329. RUBANOVSKAYA, A. A., and USHAKOVA, V. F. Accumulation of radioactive strontium in the bones of rats in chronic administration via the stomach. Mater. Toksikol. Radioaktiv. Vesheh. (Moscow: Gosud. Izdatel. Med. Lit.) Sborn. 1: 13-16. 1957.

"After 24-27 days' administration of Sr^{89} and Sr^{89+90} the bone activity is affected only slightly. After a given time the absorption of Sr^{89+90} by the bones becomes reduced and an equil. occurs between the elimination from and the absorption by the bones of the Sr." (Chem. Abs. 52: 2262.)

330. SIPOVSKII, P. V. Redistribution of calcium salts in bone tissue as one of forms of reactive changes. Ortop. Travmatologiya i Protezirovaniye Moskva 4: 3-8. 1955.

331. SOGNAES, R. F. Relative significance of cellular and chemical remodelling of bones and teeth as revealed by radioactive isotopes. Oral Surg., Oral Med. and Oral Path. 10: 167-174. 1956.

"The results of radio-active tracer studies on the teeth and bones of rhesus monkeys using radioactive phosphorus (P^{32}), iodine (I^{131}), potassium (K^{42}), sodium (Na^{24}) and tritium water (HTO) are discussed. Ion exchange in bone is compared with that in teeth and special reference is made to the two-way exchange possible in teeth, that is from the pulpal surface and from the enamel surface." (Internatl. Abs. Biol. Sci. 7: 3203.)

332. SOGNAES, R. F., SHAW, J. H., and BOGOROCH, R. Radiotracer studies on bone, cementum, dentine and enamel of rhesus monkeys. Amer. Jour. Physiol. 180: 408-420. 1955.

"The relative distribution of P^{32} , I^{131} , K^{42} , Na^{24} , and H^3 was detd. in bone, cementum, dentine, and enamel of rhesus monkeys, 5 min. to 5 hrs. after radioisotope administration by various routes. After intravenous injection

of I^{131} there was a relatively uniform isotope distribution throughout the mesenchymal hard tissues at a level 5–100 times higher than in the enamel of unerupted and erupted teeth, resp. These levels did not change appreciably from 5 min. to 5 hrs. In functioning bones and teeth, after intravenous injection of P^{32} , there was a decreasing radioisotope uptake in the order: Alveolar bone, calvarium, shaft of long bone, cementum, internal dentine, external enamel, external dentine and internal enamel. Intravenously administered I^{131} , P^{32} , K^{42} , Na^{24} , and H^3 were transported from the internal blood supply through dentine and enamel into the surrounding salivary environment; externally applied I^{131} was transported through enamel and dentine to become concd. in detectable quantity in thyroid and urine." (Chem. Abs. 49: 9787.)

333. U.S. ATOMIC ENERGY COMMISSION. Quarterly report, January–March. U.S. Atomic Energy Comm. UCRL–683, 105 p. 1950.

"Contents include the metabolic properties of Pu and allied materials (Sr^{90}), including radioautographic studies, tracer studies, decontamination and bone-metabolism studies, decontamination studies, distribution and movement of electrolytes in acute radiation injury, As^{211} effects on thyroid, radiochemistry; biophysical approaches to atherosclerosis; health chemistry and physics." (Author's summary.)

334. URIST, M. R., and MacDONALD, N. S. The function of the donor tissue in bone graft operations: Observations on the cement line, the mineral content, and the retention of radioactive isotopes of calcium, strontium, and yttrium in bank bone. U.S. Atomic Energy Comm. UCLA–400, 26 p. 1957.

"The experiments in this report show, with the aid of radioisotope-labeled rabbit bone transplants into clean hosts, that the donor tissue can accomplish its purpose (to induce the host to fill a defect, to fuse a joint, to unite a fracture) when only one-third or less of its total mass has been absorbed and replaced by the host. The bone matrix and the bone mineral are absorbed together and the labeled constituents are dissolved and carried into the systemic circulation of the host and not transferred locally to the host bed. When a bone graft "takes," the donor tissue becomes fastened to the host by a layer of cement substance formed by the host, probably by means of condensation of mucopolysaccharides with the histochemical characteristics of chondroitin sulfate. When a bone graft operation fails, the donor tissue does not become cemented to new bone produced by the host. Instead it becomes encapsulated in an envelope of fibrous tissue and is virtually outside the body. The host grows into the donor tissue in an orderly pattern and not by haphazard growth. The trabeculae of new bone from the host bed grow into the donor and each one finds a trabecula of dead bone on which to cement itself. Thus the function of the donor tissue in all bone graft operations is to provide an absorbable network of surfaces upon which the host condenses the cement and deposits the new bone." (Author's summary.)

335. VAN MIDDLESWORTH, L. Study of plutonium metabolism in bone. U.S. Atomic Energy Comm. MDCC–1022, 99 p. 1947.

"A method is described whereby Pu^{239} , Sr^{90} , and Y^{88} may all be distinguished in the same animal by differences in their radiations. The chronic excretion of Pu^{239} , Sr^{90} , and Y^{88} was followed for 11 weeks in rats injected simultaneously with these three elements. The very low rate of elimination of all three after the first month emphasizes the danger of chronic toxicity. Radioautographs of the tibia show radioactive strontium deposited throughout the bone with a heavy concentration in the region of new bone growth and active calcification beneath the epiphysis. Plutonium was shown to localize superficially in the endosteal and periosteal surfaces of the bone with no apparent concentration in the zone of bone growth and calcification. Severe phosphate deficiency was found to diminish greatly the retention of radioactive

strontium in the skeleton. The retention of plutonium at the site of intramuscular injection was reduced in the phosphate-deficient rats, but the distribution of plutonium in the body was otherwise unchanged. The maximum uptake of Pu^{239} and Y^{88} in the fracture callus occurred on the second or third day after fracture, before calcification had commenced. On the other hand, active Sr^{90} deposition did not begin until the 4–5 day, and reached a peak at 8–12 days when calcification was most active." (Author's summary.)

336. VERNE, J., and others. The fixation of sulfur-35 in cartilages. Histophysiological correlations. Ann. d'Histochem. 1: 191–198. 1956.

J. Bessel-Liversac, B. Droz, and L. Oliver, joint authors. $Na_2S_{35}O_4$ was injected subcutaneously, 1 mc./500 g. body weight, in neonatal cats and fetal and adult rats. Autoradiographs were taken of cartilages after treatment varying from 1 to 30 days. Most active uptake occurred in precartilaginous blastemas, in and around the chondrocytes in young hyalin cartilage, and in preossifying cartilage. Little uptake occurred in cellular, fibrous, or articular cartilages.

337. YAMAMOTO, D. Goldschmidt's classification of elements and radioactive isotopes liable to deposit in the bone. Kagaku [Tokyo] 25: 261. 1955.

"Radioactive isotopes which are liable to deposit in the bone tissue are Sr^{90} , Y^{91} , Zr^{95} , Nb^{95} , Ba^{140} , La^{140} , Ce^{144} , Pr^{143} , Pm^{147} , Pa^{231} , Th^{239} , Np^{239} , Pu^{239} , Am^{241} , and Cm^{242} . Most of these elements belong to the lithophilic element in G's geochem. classification of elements (C.A. 31, 49256). The fact suggests that the principle of element distribution proposed by G. would also be applied to living bodies." (Chem. Abs. 49: 16001.)

Bone-Salt Metabolism and Growth Processes of the Bone

338. AMPRINO, R. The growth and the modification of bone studied by use of radiocalcium. Compt. Rend. Assoc. Anatomistes XXXIX^e Reunion, Clermont-Ferrand, 7–9 April, 1952, 6 p. 1952.

339. ARMSTRONG, W. D. Radiotracer studies of hard tissues. N.Y. Acad. Sci. Ann. 60: 670–684. 1955.

"After injection of Ca^{45} and Na^{22} , the concn. of Ca^{45} in plasma fell more rapidly than Na^{22} and continued to fall long after equil. of Na^{22} was reached. The skeleton of a 20-kg. dog exchanged 1 g. of Ca and 8.2 g. Na (half the skeletal Na) by 150 min. It is suggested that the labeled ions in the body fluids replace an equal no. of unlabeled ions in bone salt. *In vitro* exchange of Ca^{45} and P^{32} -labeled apatite with solns. contg. Ca or phosphate suggest that the apatite mol. is turned over as a unit in physiol. concn. At high concn. the Ca and phosphate of the apatite appear to exchange independently. Exchange studies with $Na_2C^{14}O_3$ and glycol-KOH ashed bone show a logarithmic relation between uptake of C^{14} and its concn. Identical amts. of Na and carbonate were removed from soln. by the bone mineral. It was observed that loss of C^{14} occurred from dried samples of bone stored over P_2O_5 . 19 references." (Chem. Abs. 49: 12645.)

340. ARNOLD, J. S. Autoradiographically determined *in vivo* translocation of Ra^{224} from skeletal deposits of Th^{228} . Radiation Res. 3: 1. 1955.

"Radioautographic studies reveal that the decay products of Th^{228} , which deposited like plutonium in bone, translocated histologically according to the metabolism of the elements. The fate of the daughter products is of particular importance, since they produce four of the five α -particles in the decay series. Ground sections were prepared of humoral shafts of three dogs sacrificed from 65 to 104 days after Th^{228} administration. A series of contact autoradiographs were prepared through repeated exposures made at the same exposure intervals. Three series were prepared with exposure intervals of 24 hours, 48 hours, and 8 days. Exposures were begun several hours

after death and continued until radioactive equilibrium had occurred. The variety and relative amounts of some of the decay products were determined by analysis of growth and decay curves derived from track counting and densitometric analysis of the autograms produced by various types of bone and deposition patterns. It was found that substantial amounts of activity were deposited diffusely in mature bone, which had been formed a short time before Th^{228} administration. This material was identified as Ra^{224} , free of Th^{228} . The plutoniumlike Th^{228} deposits were found to be greatly depleted of daughter products at the time of sacrifice. Less than 20 percent of the equilibrium amounts of Ra^{224} was present in most Th^{228} deposits." (Author's abstract.)

341. ARNOLD, J. S. Plutonium and radium in bone. U.S. Atomic Energy Comm. ANL-5584, p. 131-143. 1956.

"Expts. with Sprague-Dawley rats have shown that Pu was transferred from bone to soft tissue by treatment with 300 units of parathyroid ext. About 45% of the anticipated skeletal Pu (23% of total given) disappeared from the bone of animals treated with 300 units of parathyroid ext. Since the excretion of Pu was not remarkably greater in the parathyroid-treated than in control rats, the Pu lost from bone can be assumed to have transferred to soft tissues. Of this 23% of the administered Pu lost from bone, about $\frac{1}{2}$ is to be found in the liver and spleen, the rest probably being located in other less defined elements of the reticuloendothelial system. The data fail to show a change in the skeletal Pu content in the animals treated with only 100 units of parathyroid ext., but do show a suggestion of accumulation of Pu in the liver and spleen samples. The mechanism by which parathyroid ext. facilitated the loss of Pu from bone is not clear. Pu can be mobilized by activated cellular elements participating in the process of bone resorption and subsequently be excreted in a colloidal org. bound form into blood. Parathormone may bring about the liberation of some large mol. material (probably polysaccharide) from bone, which acts as a Pu-binding material. A more remote possibility is that parathormone may induce a change in bone matrix, reducing its binding strength for Pu. Pu-poisoned patients rapidly become refractory to parathyroid ext. action after a few doses, and it is rather toxic." (Chem. Abs. 51: 4557.)

342. AUB, J. C. Bone metabolism studied by radioactive lead and radium. Indian Jour. Child Health 3: 601-607. 1954.

"Bone has 2 parts, the cortex which has the function of supporting the body and the spongiosa or cancellous bone tissue which acts as a reservoir of inorganic salts for the metabolic functions of the body. Previously published studies by the author with the use of cats on low Ca diet, animals treated with alizarin red and patients accidentally exposed to Ra reveal that the bone trabeculae have a rapid metabolism and that the cortex has a slow metabolic rate. New observations with the use of radioactive Pb injected in dogs provided an accurate quantitative approach to this subject and gave comparisons of the concentration and rate of migration of radioactive elements of bone tissues. Forty-five days after i.v. injection of radioactive Pb there was 11 times as much stored in the trabeculae as in the cortex of the bone. 179 days after i.v. injection of radioactive Pb there was only 5 times more Pb in the trabeculae than in the cortex. As the bone grows the Pb which was present in the spongiosa near the epiphysis continues to be dissolved over and over again and redeposited. This Ca and Pb is probably carried away in the blood stream and redeposited, but it is possible that some local migration may occur. Bone growth therefore has a rapid metabolism of inorganic salts which is analogous to that found in the bone trabeculae. An equilibrium between the salts and the bone spongiosa and in the cortex can be reached, but it requires many years. This was observed in a patient who had had i.v. injections of Ra as a fad-treatment 15 yr. prior to the development of a bone sarcoma. An equilibrium had been reached between the concentration of salts and the bone trabeculae

and in the bone cortex. In teeth extracted from animals after radioactive Pb was injected, it was found that the amount of the isotope concentrated in dentin was analogous to that concentrated in the cortex of the bone." (Excerpta Med. 8: 5203.)

343. BAUER, G. C. H. The importance of bone growth as a factor in the redistribution of bone salts. A. Redistribution of radioactive calcium in the skeleton of rats. Jour. Bone and Joint Surg. 36-A (2): 375-380. 1954.

"Twenty-seven rats were fed 20 mg. of aqueous Ca^{45} lactate by means of a stomach tube when the animals were 6 weeks of age. With a period of 67 days, the radioactive Ca was distributed and redistributed in different parts of the skeleton in proportion to the rate of growth of each part. No equilibrium was found between body fluids and diaphyseal bone. After 50 days the specific activity of Ca of the diaphysis was higher than that of the epiphysis." (Biol. Abs. 28: 26162.)

344. BAUER, G. C. H. The importance of bone growth as a factor in the redistribution of bone salts. II. Redistribution of radioactive phosphorus in the skeleton of rats. Jour. Bone and Joint Surg. 36-A (2): 381-386. 1954.

"Eighteen rats, 7 days old were treated with subcut. injns. of approx. 20 μc . of radioactive P (P^{32}). The distribution and redistribution of radioactive P was in proportion to the rate of growth of the various parts of the skeleton. Ionic exchange and recrystallization of bone salts quantitatively are much less significant than uptake by cellular activity and growth of new bone. The different areas of the skeleton never reach equilibrium with respect to distribution of radioactive P." (Biol. Abs. 28: 26163.)

345. BAUER, G. C. H. Rate of bone-salt formation in a healing fracture determined in rats by means of radiocalcium. Acta Orthop. Scand. 23: 169-191. 1954.

"Mature female rats with fractured femurs were treated subcutaneously with radio-Ca as the gluconate. Animals were sacrificed from 1 hr. to 32 days later. The rate of bone-salt formation in the 7-day-old callus was equiv. to 0.04 mg. Ca/hr., much higher than normal. The newly formed bone salt remained 45 days before resorption or exchange. The bone salts of the metaphyseal ends of the fractured femur were resorbed faster than the salts from the ends of the intact femur. The rate of formation and resorption was increased in the tibia of the fractured side." (Chem. Abs. 48: 13014.)

346. BAUER, G. C. H., and CARLSSON, A. Metabolism of bone salt investigated by simultaneous administration of Ca^{45} and P^{32} to rats. Jour. Bone and Joint Surg. 37B: 658-662. 1955.

"By using Ca^{45} and P^{32} in young rats it was shown that Ca and P are laid down in bone at related rates, i.e., the ratio of Ca/P deposition in tibial shafts is 2 to 1." (Chem. Abs. 51: 8928.)

347. BAUER, G. C. H., and CARLSSON, A. Rate of bone salt formation in a healing fracture determined in rats by means of radiophosphorus. Acta Orthop. Scand. 24: 271-274. 1955.

"The P uptake, mg./hr. in fracture callus over the time interval 0.1 day was 0.046; 0-2 days 0.032; 0-3 days 0.035; 0-4 days 0.035; and 0-5 days 0.024." (Chem. Abs. 49: 16194.)

348. BAUER, G. C. H., CARLSSON, A., and LIND-QUIST, B. Bone salt formation measured in infants by means of phosphorus-32. Acta Paediatrica 44: 477-486. 1955.

"A technique was developed for evaluation of the rate of new formation (accretion) of bone salt in infants by means of P^{32} . In the proximal part of the tibia shafts of normal infants the percentage of bone salt added through accretion was estd. at about 0.05% per hr., i.e. about 5 times the net increase." (Chem. Abs. 50: 6615.)

349. BAUER, G. C. H., CARLSSON, A., and LIND-QUIST, B. Evaluation of accretion, resorption, and exchange reactions in the skeleton. *K. Fysiografiska Sällsk. Lund, Förhandl.* 25: 3-18. 1955.

"A discussion, review, and reevaluation of the use of Ca^{45} , P^{32} , and Na^{22} in studying the metabolism of the skeleton in normal and pathol. states in humans and animals (mainly rats). Difficulties arise from the fact that the isotopes are taken up by the skeleton and then removed again (exchange reactions) (I), independently of true anabolic and catabolic processes. Accordingly, corrections must be made for I. Besides maintaining the normal architecture of the bones, their resorption process is mainly responsible for the role of the skeleton in the Ca homeostasis of the body. A previously reported diurnal variation in the Ca uptake of the incisors of rats (cf. C.A. 47, 715b) was probably due to exptl. error. Bone resorption is an active process requiring the presence of vitamin D for its normal homeostatic function (cf. C.A. 47, 715d). No difference in action between vitamin D_2 and dihydro-tachysterol (II) could be detected, except that II had a much narrower therapeutic range. 32 references." (Chem. Abs. 50: 13240.)

350. BAUER, G. C. H., CARLSSON, A., and LIND-QUIST, B. Bone salt metabolism in human rickets studied with radioactive phosphorus. *Metabolism, Clin. and Expt.* 5: 573-581. 1956.

"The rate of bone salt accretion, as detd. by use of P^{32} , in 2 children with deficiency rickets was lower than in children of the same age, but was restored to normal by the administration of vitamin D. In 2 children with vitamin D-resistant rickets the accretion rate probably was normal; however, after treatment with massive doses of vitamin D the accretion rate increased over that seen in normal children of comparable age. The findings indicate that the source of P of the bone salt formed in rachitic children following treatment with vitamin D is both dietary and from mobilization of skeletal P. The authors conclude that the treatment of rickets with vitamin D leads to an increase in both bone salt accretion and resorption rates." (Chem. Abs. 51: 568.)

351. BAUER, G. C. H., CARLSSON, A., and LIND-QUIST, B. Accretion rate of bone salt in osteoporosis studied by means of P^{32} . *Acta Med. Scand.* 158: 139-142. 1957.

"By means of P^{32} the accretion rate of bone salt was determined in a case of so-called idiopathic osteoporosis. The value obtained was about one-third of that of a normal subject." (Author's summary.)

352. BAUER, G. C. H., CARLSSON, A., and LIND-QUIST, B. Bone salt metabolism in humans studied by means of radiocalcium. *Acta Med. Scand.* 158: 143-150. 1957.

"A technique was developed for the evaluation of the rate of accretion of bone salt in humans by means of Ca^{45} . The accretion rate in the entire skeleton can be computed from activity detns. on serum samples and on excreta. The magnitude of the exchangeable Ca space can be calcd. In subjects with a normal skeletal metabolism the accretion rate rose with increasing age to a max. during early adolescence and then slowly declined to a level of about 0.5 g. of Ca/day. In adults the exchangeable fraction was almost 5 g." (Chem. Abs. 52: 3071.)

353. BURSTONE, M. S. Esterase activity of developing bones and teeth. *Amer. Med. Assoc. Arch. Path.* 63: 164-167. 1957.

"Esterase activity was found in the matrix of bones and teeth of young mice, and this was inhibited by F-, benzethonium chloride, and benzalkonium chloride, but not by E-600 or isopropylfluorophosphate." (Chem. Abs. 51: 9832.)

354. CAMERON, D. A., and ROBINSON, R. A. Electron microscopy of epiphyseal and articular cartilage

matrix in the femur of the newborn infant. *Jour. Bone and Joint Surg.* 40-A: 163-170. 1958.

"The cartilage at the distal end of the femur in newborn infants is divided into two structurally different units. The matrix at the articular surface contains bundles of fibrils, which are 250 to 500 angstrom units in diameter and have the periodic structure of collagen. They end abruptly on the joint surface and do not appear to be covered by a membrane of acellular or cellular matter. In the matrix of the remainder of the cartilage the fibrils are much less densely packed and show slight tendency to form fiber bundles. In this loose network almost all the fibrils are less than 250 angstrom units in diameter. In these fibrils no periodic structure has been demonstrated regardless of the staining method employed with both phosphotungstic and osmic acids. Occasional large fibril-like structures without evident periodic banding found in the matrix of the proliferative zone, circular structures in the zone of degenerating cartilage cells, and the stellate prolongations of the periphery of some cartilage cells out to the matrix only suggest the possibility of protoplasmic extensions of the cells into the matrix." (Author's summary.)

355. COHEN, J., and others. Radioactive calcium tracer studies in bone grafts. *Jour. Bone and Joint Surg.* 39-A: 561-577. 1957.

C. J. Maletskos, J. H. Marshall, and J. B. Williams, joint authors.

"Homogenous bone grafts in dogs were studied by implantation of radioactive bone from donor dogs previously injected with Ca^{45} and by implantation of nonradioactive bone into hosts injected with Ca^{45} prior to, during, or after the grafting procedure. Determinations of serum and bone specific activities were made and compared. A procedure for quantitative autoradiography was developed and applied to the analysis of cross sections of grafted and nongrafted areas. The activity in cross sections of the shafts of the long bones consisted principally of a general diffuse component, the specific activity of which was relatively constant over the 100-day period of study and was proportional to the administered dose. Upon this diffuse component were superimposed a few intense hot spots and often a ring of increased activity in or near the endosteum or periosteum. The hot spots corresponded to individual Haversian systems, and their specific activities ranged up to 35 times that of the diffuse component as determined with an autoradiographic resolution of 120 micra. The distribution of Ca^{45} from radioactive grafts was systemic and no preferential transfer of Ca^{45} to callus or nearby bone was detected. In dogs that received nonradioactive grafts and injections of Ca^{45} , the specific activity of the callus was the highest observed anywhere in bone, up to 100 times that of the diffuse component of the host's cortical bone and was strongly dependent on the relation between the time of injection and the time of grafting. The time of calcification of callus occurred predominantly at about the third week after grafting. Relocation of localized deposits of activity without dilution in the whole volume of circulating blood (hot-spot migration) to or from graft areas was not detected in this experiment. The data of this experiment provided two points that are considered pertinent and applicable to the problem of radiation-hazard evaluation with respect to radioactive materials fixed in bone. These are the proportionality between the administered dose and the specific activity of the diffuse component and the large ratio between the specific activity of hot spots and that of the diffuse component." (Author's summary.)

356. COMAR, C. L., LOTZ, W. E., and BOYD, G. A. Autoradiographic studies of calcium, phosphorus and strontium distribution in the bones of the growing pig. *Amer. Jour. Anat.* 90: 113-125. 1952.

"The deposition and removal of Ca^{45} , P^{32} , and Sr^{90} from the skeleton of the weanling pig have been demonstrated using the autoradiographic method. Regions of periosteal origin were characterized by sharp images in the autoradiogram, relatively slow deposition, and slow removal.

Regions of endochondral origin were characterized by diffuse images, rapid deposition, and rapid removal. Possible explanations in terms of exchange and metabolic functions are presented. An autoradiographic method is presented for the estimation of rate of growth of various parts of the bone." (Nuclear Sci. Abs. 6: 2842.)

357. DE LANCIE, M. F. Bone healing in rats using radioactive calcium. Fed. Proc. 14: 201. 1955.

"Experiments were carried out in an attempt to correlate histological and chemical changes in fracture repair. The left radius of adult female rats was fractured and its repair was observed for periods up to 120 days after fracture. Ca^{45} was administered intraperitoneally 24 hours prior to killing each animal. The normal right radius, as well as the radii of animals without fracture, served as control groups and thus permitted comparison of fractured bone with normal bone both in the absence or in the presence of a fracture. Observed increases in water content of fractured bone coincided with the early period of hematoma and callus formation and later with the period of new-bone formation. In both fractured and unfractured bone the calcium content remained unaltered throughout the repair period. However, there was a marked increase in Ca^{45} uptake and turnover in the fractured radius and a parallel though lesser increase in its normal homolog. The changes in Ca^{45} metabolism coincided with the period of marked mineralization of repair tissue—10–30 days after fracture. The results indicate that (1) a distinction should be made between functional and complete repair—35 versus more than 120 days, (2) healing bone and growing bone are essentially similar in behavior, and (3) in the presence of a fracture there is an increase in general skeletal metabolic activity per se rather than participation of the skeleton in fracture repair." (Author's summary.)

358. ENGFELDT, B., ENGSTROM, A., and ZETTERSTROM, R. Renewal of phosphate in bone minerals. II. Radioautographic studies of the renewal of phosphate in different structures of bone. Biochim. et Biophys. Acta 8: 375–380. 1952.

" $\text{P}^{32}\text{O}_4^{3-}$ is distributed in bone tissue unevenly so that young Haversian systems (I) with low mineral salt concns. have the highest uptake of P^{32} and the old I have a reversed condition. Rapid initial uptake of P^{32} appears to be due to differences in soly. and recrystns. rather than surface reactions throughout whole bone tissue." (Chem. Abs. 47: 7619.)

359. ENGSTROM, A. Structure of bone from the anatomical to the molecular level. Ciba Found. Symp. Bone Structure and Metabolism 1955: 3–13. 1956.

Previous work is reviewed and interpreted and new data are added. When Sr^{90} was administered to a dog (sacrificed 1 week later), the endosteal end of the femur and certain Haversian systems showed a high uptake of the isotope, although the mineral content was otherwise low. From the histological down to the molecular level, bone has the characteristics of a system in intimate contact with the tissue fluids, so that changes in the surface composition of crystallites can occur at a very high rate.

360. FRADKIN, G. E. Mechanisms of the processes of accumulation in and elimination from the organism of radioactive isotopes of alkaline earth, rare earth and heavy elements. Med. Radiol. 2: 13–18. 1957.

"The radioactive isotopes of alk. earth (Sr, Ba), of rare earth (Y, Ce, etc.), and of the heavy elements accumulate in the bone tissues as the result of destruction in the bone tissues of complexes of the above elements with amino acids. This was also the cause of retention in the liver of some Y, Ce, and Pu. Radioactive isotopes of Th and Po, the salts of which possess well-defined properties of hydrolysis and the formation of hydroxides, were retained in the organism as the result of phagocytosis. The reaction of radioactive elements with proteins and anionic pptg. agents occur only in the presence of free radioactive cations." (Chem. Abs. 52: 6612.)

361. FREDERICKSON, J. M., HONOUR, A. J., and COPP, D. H. Measurement of initial bone clearance of Ca^{45} from blood in the rat. Fed. Proc. 14: 49. 1955.

"Rats were injected intravenously with 0.1 ml. of isotonic saline containing Ca^{45} (6 μc .) with 0.002 mg. of Ca. Frequent blood samples were taken during the first 5 minutes, and the animals were then promptly killed. Curves for blood concentration of Ca^{45} were drawn, and the integrated average over this period was used in computing clearance values from the uptake of Ca^{45} by the bones. If one assumes that all the Ca^{45} flowing through the bone capillaries during this initial period is replaced by non-radioactive Ca through exchange with the excess calcium in bone salt, these clearance values will be a measure of effective bone blood flow. In any case, the bone blood flow must equal or exceed these values. The clearances, expressed as milliliters of whole blood/minute/ m^2 body surface were as follows: young rats (7)—femur 4.94 ± 0.61 , scapula 2.01 ± 0.17 , skeleton 127 ± 10 ; adult rats (6)—femur 2.66 ± 0.12 , scapula 1.66 ± 0.09 , skeleton 71 ± 7 . Results indicated that the bone blood flow was at least 0.1–0.3 ml./minute/gram tissue and was similar in the two age groups. The flow for the whole skeleton appeared to be at least one-fifth of the blood flow reported for the rat kidney." (Authors' summary.)

362. HARRIS, N. O. The role of the radioactive isotope in bone metabolism. Mil. Surg. 114: 108–111. 1954.

"Experiments utilizing radioactive nuclides in the study of bone metabolism indicate that various elements have a specificity for either the apatite crystal or the organic matrix. Once the matrix-seeking elements, such as yttrium, americium, and plutonium, have been incorporated, the usual resorptive procedures are ineffectual in accomplishing their release. Conversely, elements that enter into the mineral phase, such as calcium, strontium, and phosphorus, are sensitive to parathyroid hormone administration, scurvy, and vit. D deficiency. Physico-chemical reactions must be considered in all isotopic studies. Colloidal particle size is important in ultimate localization; while ion exchange reactions complicate evaluation of normal metabolic uptake gradients for the various nuclides. In the therapeutic use of radioactive isotopes, decay time is important. Thus application is limited by either too short a half-life, making use impractical, or by too long a half-time, resulting in hazardous radiation levels. Experimental administration of excessive activity is followed by histological alteration of osseous tissue, the extent of damage depending on the type of radiation. This change is marked by early disappearance of osteoblasts, degeneration of osteocytes and hypertrophy of cartilage cells. The erythropoietic series has proved more susceptible than the granulocytic. After destruction of the cellular elements a fatty and gelatinous marrow results. Ensuing repair may be patchy possibly with replacement fibrosis, abnormal bone formation or changes that are harbingers of osteogenic sarcoma." (Excerpta Med. 8: 793.)

363. HELLER, J. H., and others. A method of measurement of the dynamics of bone healing. Fed. Proc. 16: 57. 1957.

H. Konig, L. Fox, and A. Torok, joint authors.

"To investigate the dynamics of bone healing in vivo, a technique was devised using the gamma-emitting isotope strontium 85. Sr^{85} has no beta emission. Since it was expected that strontium or calcium would concentrate heavily at the site of a healing lesion, it was felt desirable to avoid a gamma-emitting isotope, which also emits a beta particle such as calcium 47 in order to minimize ionization damage at the fracture. In addition, the 65-day half life of Sr^{85} makes it more useful for study of a lesion throughout the healing process as opposed to the 4.8-day half life of Ca^{47} . Furthermore, the 0.51 Mev. gamma of Sr^{85} is much easier to shield against than the 1.3 Mev. gamma of Ca^{47} . In order to reduce the amount of isotope needed for injection to the absolute minimum, a gamma ray spectrometer was used. The scintillation crystal was shielded by 9 cm. of lead, and the lesion was

measured through an orifice in the shielding, which was 2 mm. in diameter. Various bone lesions were induced in experimental animals. The Sr^{85} uptake at the site of the lesion, as well as control values from the normal contralateral limb, was taken at daily intervals. Some of the dynamics of bone healing as determined by this method are discussed." (Author's abstract.)

364. HOLLINGSHAUS, H., and MAYS, C. W. Changes in mechanical strength of bone due to internally deposited radioelements. Utah Univ. Radiobiol. Lab. Ann. Prog. Rpt. AT (11-1)-119, 158-179. 1958.

"The strength of intact beagle tibiae was measured. In uninjected dogs the breaking stress and modulus of elasticity increased with age. In dogs injected with bone-seeking radioelements, the breaking stress and modulus of elasticity decreased as the radiation dosage increased." (Author's abstract.)

365. JEE, W. S. S., and ARNOLD, J. S. Rate of individual Haversian system formation. Anat. Rec. 118: 315. 1954.

"As a part of a series of experiments on bone growth and calcium metabolism, the rate of formation of individual secondary Haversian systems was investigated radioautographically using Ca^{45} in the tibiae of growing rabbits. Studies were made on animals sacrificed at 1, 7, and 21 days following Ca^{45} administration (Arnold and Jee, '53). Bone which was actively depositing at the time of Ca^{45} administration was detected by its ability to concentrate Ca^{45} . All secondary Haversian systems which concentrated Ca^{45} were classified as to the stage of formation at both time of injection and time of sacrifice. The data indicate that the rate of bone apposition is greatest during the first half of the process of Haversian system formation (filling of a resorption cavity). This is demonstrated by two types of data: (1) the frequency distribution of various stages of formation and (2) direct measurement of bone deposition in individual Haversian systems after 7 and 21 days. At the time of Ca^{45} administration 60-70% of forming Haversian systems of all animals were more than half completed. Growth arrest was frequently observed in all stages of formation. Of the Haversian systems which were just beginning formation at the time of Ca^{45} administration, 20-30% were completed after 21 days." (Anat. Rec. Abs.)

366. LACROIX, P. Radiocalcium and radiosulfur in the study of bone metabolism at the histological level. Oxford Radioisotope 2d Conf., Med. and Physiol. Appl., Proc. 1954: 134-137. 1954.

Autoradiographs and microradiographs were obtained from transverse ground sections of the diaphyses from adult dogs 7 days after intraperitoneal injection of 400 μc . of Ca^{45} /kilogram. The radioactivity was detected only in the regions where osteogenesis was going on, more specifically in the absorption cavities, which were being filled by concentric lamellae of new bone. The skeleton retained 85 percent of injected Ca^{45} and only 5 percent of S^{35} . Autoradiographs obtained with S^{35} were similar to those with Ca^{45} . Apparently some S compound plays a part in the formation of new osteons. This may be a mucopolysaccharide.

367. LACROIX, P. Histological remodelling of adult bone. An autoradiographic study. Ciba Found. Symp. Bone Structure and Metabolism 1955: 36-46. 1956.

Previous work is reviewed and new experimental data are presented. In the calcification of compact bone in the dog, about 75 percent of the final amount of Ca is stored by the osteon (Haversian system) initially, the remainder after osteogenesis has ceased. Microradiograph data (after administering Ca^{45} or S^{35}) do not give a complete account of osteon formation. Histochemical staining methods (discussed) indicate that in the fully deposited osteon, metachromasia is inversely proportional to the Ca content. In the formation of adult bone, active S metabolism precedes that of Ca. Histological and histochemical details are considered. In research on cancellous

bone in dogs, microradiographs revealed that the trabeculae are made up of layers of varying Ca content. There is an initial formation of a preosseous, uncalcified orthochromic layer, in which a metachromatic layer with a strong affinity for Ca suddenly appears. This effect is more easily observed in the metaphysis than in the epiphysis. In the osteon of human bone the Ca is alternately low and high from one lamella to the other. 33 references.

368. LEBLOND, C. P., BELANGER, L. F., and GREULICH, R. C. Formation of bones and teeth as visualized by radioautography. N.Y. Acad. Sci. Ann. 60: 631-659. 1955.

"With the fluid coating or inverting technique of radioautography, five details of matrix formation and mineral deposition may be seen in developing hard tissues. Enamel shows a clear-cut discrepancy between the appearance of matrix and mineral, as deposition of S^{35} -sulphate, and C^{14} -bicarbonate occurs before that of P^{32} -phosphate and Ca^{45} ion. The matrical labels disappear where mineral labels are accumulated. Dentine, and presumably bone, matrix is elaborated in two steps. Predentine is formed with the incorporation of C^{14} -bicarbonate. S^{35} -sulphate addition transforms this into true dentine matrix. This matrix takes up phosphate and calcium salts." (Internatl. Abs. Biol. Sci. 4: 1606.)

369. MacDONALD, N. S., LORICK, P. C., and PETRIELLO, L. I. Healing bone fractures and simultaneous administration of radioisotopes of sulfur, calcium and yttrium. Amer. Jour. Physiol. 191: 185-188. 1957.

"A mixture of carrier-free radioisotopes, Ca^{45} , S^{35} , and Y^{91} , was injected into rats bearing left tibial fractures in states of repair varying from 3 to 18 days. Twenty-four hours after injection both tibias were removed and analyzed for content of each radioisotope. At all intervals up to 18 days postfracture the injured bone contained more of all three isotopes than the intact contralateral mate. A maximum in 24-hour retention of radiosulfate in tissue at the fracture site was reached by the 7th to 10th day, after which retention of a dose of S^{35} declined rapidly. Retentions of a dose of Ca^{45} in the fractured bone also rose rapidly during the first 3 to 10 days of healing. Thereafter, 24-hour retention values continued to rise but at a reduced pace. The avidity of healing bone for yttrium increased sharply during the same 3- to 10-day interval, during which radiosulfate deposition became most effective. After this time 24-hour retention values for Y^{91} increased only slightly, if at all. The data suggest that formation of the sulfated mucopolysaccharides of osteoid matrix and fibrocartilaginous callus began by at least the third day, if not earlier. The healing fracture made its greatest demands for plasma sulfate during the 7th to 10th day postfracture. New calcium was laid down at the fracture site just as early as new sulfate, but the demands for plasma Ca continued throughout the 18 days of observation, as might be expected for a mineralizing callus. Yttrium fixation in the healing bone appeared to be more closely related to events leading to organic matrix formation than to mineralization of the new tissue." (Author's abstract.)

370. McLEAN, R., CALHOUN, J. A., and AUB, J. C. Migration of inorganic salts in bone as measured by radioactive lead and by alizarin. Arch. Indus. Hyg. and Occup. Med. 9: 113-121. 1954.

"No real difference in total Pb stored in the humerus was found in dogs receiving tagged Pb or inert Pb compds. The concn. of tagged Pb deposited in long bone trabeculae is 5 to 16 times that of the cortex, but the mass of the cortex is much greater. The amt. of tagged Pb deposited in bone and dentine is dependent on Pb dosage." (Chem. Abs. 48: 13949.)

371. MARINONI, U., and SCENDRATE, R. Study of bone implants with radioactive strontium (Sr^{90}). Gior. di Med. Mil. 106: 310-312. 1956.

372. NEUMAN, W. F., and NEUMAN, M. W. Emerging concepts of structure and metabolism functions of bone. *Amer. Jour. Med.* 22: 123-131. 1957.

373. ROSENBERG, M. L. Hypercalcemia and metabolic bone disease. *Calif. Med.* 81: 382-390. 1954.

"An address with 21 references." (*Chem. Abs.* 49: 2594.)

374. RUF, F. Studies on radiophosphorus and radio-calcium metabolism in bones, especially during fracture healing and in bone splinters. *Strahlentherapie* 33: 212-221. 1955.

375. RUTISHAUSER, E. Vascularity of bone in relation to pathological studies. *Ciba Found. Symp. Bone Structure and Metabolism* 1955: 239-248. 1956.

Mainly a pathological discussion, with attention to the chemical aspects of pathological states. The term "hyaline" applied to the connective tissue corresponds only to an optical property and does not indicate chemical composition. 21 references.

376. TOMLIN, D. H., HENRY, K. M., and KON, S. K. A study of bone growth in the rat using radioactive calcium. *Jour. Anat.* 86 (4): 475. 1952.

"The technique of autoradiography with the radioactive isotope Ca^{45} was applied to study the manner in which growing rats incorporate dietary calcium into the structure of the long bones. The rats were given a stock diet to which calcium carbonate containing this isotope was added during specific periods. In one experiment a group of rats received during alternate 3-month periods a radioactive and a nonradioactive diet, and subgroups were killed at the end of each period. In the second experiment the radioactive diet was given continuously, and subgroups were killed at intervals of 2 weeks. Both experiments began when the animals were 28 days old. The femora and humeri were removed. After being embedded in wax they were split longitudinally and the exposed surfaces ground flat. These surfaces were then placed in contact with "Crystallex" X-ray film, and after exposures of a few days satisfactory autoradiographs were developed, showing the distribution of the radioactive calcium with a resolution of approximately $50\ \mu$. When correlated with dimensional measurements, the autoradiographs showed details of the remodelling processes involved in growth. These took place with the maximum economy of bone already laid down. Resorption occurred only where existing bone material could not be incorporated into the future structure, and this was particularly striking in the early development of the diaphysis of the femur. Bone laid down in the anterior wall at the age of 28 days still remained essentially unchanged in distribution in a bone 500 days old, whereas extensive resorption completely changed the initial structure of the posterior wall. This has been interpreted as resulting from the marked curvature of the posterior wall in comparison with the straightness of the anterior wall, which allowed the latter to remain intact throughout growth." (Author's abstract.)

377. TOMLIN, D. H., HENRY, K. M., and KON, S. K. Autoradiographic studies of calcium metabolism in bones and teeth. *Nutr. Soc. Proc.* 12: iv. 1953.

"The effects of pregnancy and lactation on the bones and teeth of rats were studied by the autoradiographic method using Ca^{45} . Autoradiographs prepared from the incisor teeth of animals that had undergone pregnancy and lactation showed variations of activity in different growth zones, which did not appear in the controls. It is concluded that mineral reserves held in the cancellous bone of the mothers were sufficient to provide for the young in utero but that withdrawal of cortical bone was necessary during lactation. This withdrawal came entirely from the medullary surface of the cortex." (Excerpt from author's abstract.)

378. TOMLIN, D. H., HENRY, K. M., and KON, S. K. Autoradiographic study of growth and calcium metabo-

lism in the long bones of the rat. *Brit. Jour. Nutr.* 7: 235-252. 1953.

" Ca^{45} was used as the tracer in these expts. and the optical ds. in the various regions were compared by means of micro-photometric measurements. In the age period from 4 to 6 weeks approx. 14% of the 4-week old diaphysal bone Ca in the femur and humerus was renewed by exchange and this increased to a max. of 24% by the 16th week. Ca exchange was considerably less extensive in adult rat bones. Some evidence was found of a modification in the normal growth mechanism of the femur when the Ca intake was changed from adequate to slightly sub-optimal. It is suggested that this modification was such that less bone material was needed to produce a given cortical thickness. A similar effect did not occur in the humerus." (*Chem. Abs.* 47: 11421.)

379. TOMLIN, D. H., HENRY, K. M., and KON, S. K. Interstitial metabolism of calcium in the bones and teeth of rats. *Brit. Jour. Nutr.* 9: 144-156. 1955.

"Autoradiographs taken of longitudinal sections of long bones of rats fed Ca^{45} indicated 2 distinct processes of Ca uptake; physical growth or accretion of new material and interstitial deposition throughout the previously-deposited volume of the bone. A smooth time curve is presented for interstitial uptake of Ca^{45} , taking a rate of about 1% of the total cortical bone Ca per week. Interstitial uptake of Ca^{45} in incisor dentine was very much less than in bone, and was estimated at $<0.05\%$ per week. Exchangeable cortical bone Ca was almost negligible. It is concluded that interstitial metabolism of Ca in growing rats as demonstrated in these experiments is mainly represented by interstitial accretion, and only very slightly by a reversible exchange process." (*Biol. Abs.* 30: 31221.)

380. TREADWELL, A. deG., and others. Metabolic studies on neoplasm of bone with the aid of radioactive strontium. *Amer. Jour. Med. Sci.* 204: 521-530. 1942.

B. V. A. Low-Beer, H. L. Friedell, and J. H. Lawrence, joint authors.

"The administration of radioactive Sr to 6 cases of bone tumor prior to biopsy or amputation shows uptake chiefly by growing bone and by osteogenic tumor tissue. Various considerations seem to justify the therapeutic use of radioactive Sr in certain bone tumors." (*Chem. Abs.* 37: 2796.)

381. VAN MIDDLESWORTH, L., COPP, D. H., and HAMILTON, J. G. Uptake of plutonium, yttrium and strontium by the callus of the healing bone fractures. *U.S. Atomic Energy Comm. MDCC-666*, 2 p. 1947.

Uptake of Pu^{239} , Y^{88} , and Sr^{90} in the fractured fibula of rats was compared with that in the unbroken control bone of the opposite side. The study indicates that the deposition of strontium is related to the activity of calcification, whereas some other mechanism is responsible for the deposition of yttrium and plutonium.

382. WASSERMAN, R. H., JOWSEY, J., and COMAR, C. L. Estimation of calcium accretion and resorption in the rat. *Fed. Proc.* 17: 331. 1958.

"Total bone accretion and bone resorption rates were determined by a combination of balance and radiotracer techniques. Young male rats, placed on a complete diet, were given Ca^{45} -labeled drinking water. Representative rats were bled and killed at intervals over a 7-day period. At 7 days the survivors were given nonlabeled water and in turn were bled and killed at intervals over an additional 7-day period. Total Ca intake, Ca^{45} intake, skeletal retention of Ca^{45} , specific activity ($\text{SA} = \text{Ca}^{45}/\text{Ca}^{40}$) of plasma, and net Ca growth were measured. Total Ca retention (accretion), estimated by Ca^{45} retained/SA of ingested Ca, was found to be 2.4 mg. Ca/hour/gram of body Ca. When the calculation was made from the integrated plasma SA curve and retained Ca^{45} , the value was 2.9 mg. Ca/hour/gram of body Ca. Resorption was calculated by the difference between accretion and net Ca retention. Consideration was given to possible interference in these

values by resorption of labeled bone. Bauer et al. (Acta Physiol. Scand. 35: 56, 1955) in single injection experiments mathematically distinguished between Ca^{45} entering the skeleton by accretion versus exchange and were thus able to calculate Ca accretion rates. The present data are in good agreement with Bauer's independently obtained value of 2.7 mg. Ca/hour/gram of body Ca." (Author's abstract.)

Ion-Exchange Reactions of the Skeleton

383. ARNOLD, J. S. *In vitro* solubility and ion exchange of *in vivo*-deposited Ca^{45} in bone. Fed. Proc. 12: 383. 1953.

"These experiments were designed to give information about the mechanism by which calcium is fixed in growing and mature bone. Rabbits were given 1 mc. of Ca^{45} intravenously and sacrificed 1 hour, 24 hours, 7 days, and 21 days later. Acetone-fixed undecalcified vertebral bodies were sectioned at 8 μ . Mounted sections were gently shaken in distilled water and solutions of sodium acetate, calcium acetate, sodium phosphate, and calcium chloride at pH of 7.5-7.8. Sections were radioautographed and counted in a windowless proportional counter before and after exposure to a leeching solution. Grain counting of corresponding areas of matched radioautograms was performed to detect changes in topical Ca^{45} concentration. The experimental results are partially summarized as follows: After 1 hour 40 percent of the Ca^{45} deposited in areas of bone growth was soluble in all solutions tested except saturated calcium phosphate. Ion exchange and recrystallization loss of Ca^{45} from depositing bone is greatest at this period. A dramatic decrease in ion-exchange loss of Ca^{45} from newly formed bone occurs during the first 24 hours after deposition. No change in ion-exchange loss of Ca^{45} occurs between 24 hours and 21 days after fixation in growing bone. It would appear from the data that calcium, when first fixed in growing bone, is quite labile and soluble and is in some form of calcium phosphate. The bulk of the calcium fixed in growing bone is not fixed by simple ion exchange, as appears to be the case in mature bone." (Author's abstract.)

384. ARNOLD, J. S. Concepts of ultra structure of bone through radioactive daughter product behavior of Sr^{90} and Ra^{226} . Fed. Proc. 14: 398. 1955.

"Some radioactive materials decay in a series of steps yielding radioactive daughter products of different atomic species. When such a daughter element is produced from decay of a skeletally deposited mother element, it may remain localized or escape into the body fluids depending on its chemical nature and position within the ultra structure of bone. All data indicate that Ra and Sr are deposited by the same mechanisms within and on the surfaces of bone crystals. When Ra^{226} is skeletally fixed *in vivo*, the noble gas Rn^{222} readily escapes from areas of bone which were mature prior to Ra^{226} administration. The Rn^{222} escape is much less from bone formed during or after Ra^{226} administration (Arnold, J. S., and Jee, W. S. S., Radiation Res., Oct. 1954). These results would indicate that the limiting path of diffusion within crystalline material is shorter in "old" bone and that the mother radium is deposited closer to the crystal surfaces in old than in newly formed bone. In the presently reported experiment a 5-month-old pup was given 150 $\mu\text{c.}$ /kilogram of Sr^{90} i.v., and killed 4 months later. At the time of death the rare earthlike daughter product Y^{90} was at complete radioactive equilibrium in bone, which was formed before, during, and after the administration of Sr^{90} . This was demonstrated by serial radioautograms and energy discriminatory beta-ray counting. The finding that a noble gas daughter escapes and that a rare earthlike daughter does not escape from an alkaline earth mother element deposited in "old" bone indicates that the alkaline earth is close to the crystal surface but not at the surface. This concept is consistent with ion-exchange studies using Ca^{45} ." (Author's summary.)

385. ARNOLD, J. S., and JEE, W. S. S. Ion exchange and recrystallization in fixation of Ca^{45} in the rabbit's skeleton. Soc. Expt. Biol. and Med. Proc. 85: 658-663. 1954.

"Undecalcified bone sections of rabbits sacrificed at intervals between 1 hr. and 3 weeks after Ca^{45} administration were treated with $\text{Ca}(\text{OAc})_2$ soln. to det. what portion of Ca^{45} remains on crystal surface of the bone in exchangeable position. At 1 hr. after the Ca^{45} administration $\frac{1}{2}$ of the isotope fixed in the bone is no longer removable by ion exchange." (Chem. Abs. 48: 10168.)

386. BAUER, G. C. H., and CARLSSON, A. On the availability for exchange of skeletal water, sodium, and calcium. Acta Orthop. Scand. 24: 275-277. 1955.

"Water is completely exchangeable; 90% in 4 hrs., 100% in 24 hrs. Na assoc. with bone water is completely exchangeable and only 40% of the excess Na of bone salt exchanges. Exchange of Ca probably does not exceed 1%." (Chem. Abs. 49: 16194.)

387. BAUER, G. C. H., CARLSSON, A., and LINDQUIST, B. Comparative study on metabolism of strontium-90 and calcium-45. II. Properties of exchangeable bone calcium. Acta Physiol. Scand. 35: 67-72. 1955.

"In young rats the exchangeable fraction of the bone Ca consisted of a number of subfractions attaining the specific activity of the serum Ca at intervals ranging between one and six or eight hr. after injection of Ca^{45} ." (Internatl. Abs. Biol. Sci. 4: 5886.)

388. BLIVEN, F. E., JR., and BOYD, J. O. Phosphorus-32 exchange in delayed union of fractures. Surg. Forum, Amer. Col. Surg. 41st Cong. Proc. 1955: 533-539. 1956.

"Two patients, a 55 year old male and a 25 year old female, were given 0.614 and 0.096 mc. P^{32} orally on the day before surgery for ununited fractures. Bone samples were taken during surgery. Callus in both patients was actively forming bone. In all samples, the mineral content was uniform, except that the callus had less H_2O and ash than cortical bone, and osteoporotic bone held less H_2O . The specific activity of P^{32} was high in callus and osteoporotic bone, but low in cortical bone. In the younger patient, the activity in the callus was 50 times the P^{32} concn. in cortical bone, although mineral content was $\frac{1}{3}$ less. The uptake of P^{32} was primarily a surface-exchange reaction dependent upon absorption in the available exchange surface of the apatite crystals. Exchange began quickly after administration, and was greater in areas, such as callus, where the no. of crystals was less, hydration was greater, and the crystal was recently formed. The process required diffusion of P^{32} only through callus." (Chem. Abs. 52: 554.)

389. CALHOUN, J. A., and others. Comparative exchange of calcium, lead, and radioactive lead in dogs. Arch. Indus. Hyg. and Occup. Med. 9: 9-22. 1954.

R. McLean, J. C. Hudson, and J. C. Aub, joint authors. "When dogs received intravenous injections of $\text{Pb}_2\text{P}_2\text{O}_7$, $\text{Pb}(\text{NO})_2$, and PbCl_2 , tagged with Pb^{210} , the av. urinary excretion was 67% of the total. As much as 60 to 80% of the Pb injected was excreted during the lifetime of surviving animals. Radioactivity of the tracer portion introduced toxic effects." (Chem. Abs. 48: 13949.)

390. DALLEMAGNE, M. J., BAUD, C. A., and MORGENTHAUER, P. W. Calcium-exchange reaction in fossil bones. Soc. de Chim. Biol. Bul. 38: 1207-1211. 1956.

"The Ca exchange of fossil bone immersed in $\text{Ca}^{45}\text{Cl}_2$ soln. was studied. The exchange percentage was always lower than for fresh bone and unrelated to the age of the sample; only the correlation between the exchange percentage and the microcrystal vol. seemed valid. This vol. depended on the influence of the soil in which the bones had been buried for 400 to 12,000 years." (Chem. Abs. 51: 3689.)

391. DALLEMAGNE, M. J., BODSON, P., and FABRY, C. Exchangeable calcium of the mineral substance of bone studied by means of calcium-45. *Biochim. et Biophys. Acta* 18: 394-406. 1955.

"When bone mineral substance was sepd. from org. matter by Gabriel's method and immersed in a soln. contg. labeled Ca, it exchanged excess Ca to an extent depending on its P content. This occurred only when the soln. contained little CaCl_2 . Otherwise, in addn. to the exchange, there occurred hydrolysis followed by recrystn. which entrapped labeled Ca in the solid material. The biol. significance of the results is discussed." (Chem. Abs. 50: 5125.)

392. DALLEMAGNE, M. J., DEWITTE, R., and FABRY, C. Exchangeable calcium of the mineral substance of bone studied with the aid of calcium-45. *Soc. de Chim. Biol. Bul.* 38: 685-696. 1956.

"The exchange percentage of Ca is higher for powd. total bone than for bone salts isolated by the method of Gabriel (*Z. physiol. Chem.* 18, 257 (1894)). The difference is the result of washing with water during the purification of the bone salts. The main constituent of bone salts is octacalcium phosphate; supplementary Ca ions are fixed on the surface of the microcrystals and their exchange time (with $\text{Ca}^{45}\text{Cl}_2$) is very short. Formation of tricalcium phosphate occurs upon contact with water. The presence of the org. fraction of bone stabilizes the mineral fraction. A chem. bond exists between the mineral and the org. matrix. The Ca^{45} exchange reaction shows that the real microcrystal surface is much larger than is indicated by the crystallographic data." (Chem. Abs. 50: 17052.)

393. DALLEMAGNE, M. J., and FABRY, C. Interpretation of results furnished by the *in vitro* exchange reaction of calcium in bone salts. *Arch. Internatl. de Physiol. et de Biochem.* 65: 158-160. 1957.

394. DALLEMAGNE, M. J., and FABRY, C., and BODSON, P. The exchange of bone calcium with calcium-45. *Experientia* 11: 142-143. 1955.

"KOH-glycol ashed bone was exposed for 1 month to $\text{Ca}^{45}\text{Cl}_2$ soln. and then filtered and dried; the specific activity of this prepn. was 9.48×10^3 . Fractions of this prepn. were suspended for 10 min. in various HCl solns. After filtration and drying at 105° , Ca, P, and specific activity were ascertained for each sample. The wt. loss of the samples in HCl soln. increased with the increase of HCl used. As HCl concn. increased the specific activity of the liquid, very high for small amts. of HCl, decreased. However, the specific activity was always higher in the liquid than in the corresponding residual solid phase. For each expt. the liquid always contained more Ca than required for 9 Ca/6P (Ca/P=1.94). This excess represents the addnl. Ca ion content of bone structure. On the other hand, the Ca/P wt. ratio in the solid phase decreased slowly to 1.98. The ratio, counts per min./excess Ca, had a const. value of about 62. It is concluded that the Ca^{45} exchanged by bone mineral is exclusively the excess $1\frac{1}{2}$ moles of Ca of the satd. pseudoapatite." (Chem. Abs. 49: 11036.)

395. DALLEMAGNE, M. J., FABRY, C., and BODSON, P. Ionic exchange of calcium and recrystallization of the mineral substance of bone. *Jour. de Physiol.* 47: 153-155. 1955.

"Bone salt, prepd. by the method of Gabriel, was equilibrated with a radioactive Ca soln. contg. 6.2 mg. CaCl_2 /ml. Samples of this labeled bone salt were subsequently treated with 0.4-12.5 meq. of HCl/g. The excess Ca (the Ca present in excess of the Ca/P ratio in $\text{Ca}_3(\text{PO}_4)_2$) was shown to be the most easily exchangeable. Bone salt was equilibrated with a radioactive Ca soln. contg. 18.3 mg. CaCl_2 /ml. and then treated with successive extns. with HCl (0.2 meq./g.). In this case the radioactive Ca was found in both exchangeable and lattice Ca, indicating that recrystn. had taken place in addn. to exchange. Synthetic pure $\text{Ca}_3(\text{PO}_4)_2$, immersed in a radioactive Ca soln. contg. little CaCl_2 , did not show any

exchange. Uptake of radioactive Ca occurred only if the soln. caused a hydrolysis followed by recrystn. Thus, 2 processes are responsible for the uptake of Ca by bone salt *in vitro*: (1) true exchange, which is concerned only with the excess Ca and not with lattice Ca, and (2) recrystn. which occurs only to the degree that the Ca phosphate is attacked by the liquid phase." (Chem. Abs. 50: 6621.)

396. DAWSON, K. B. Calcium exchange in bone. *Biochem. Jour.* 60: 389-391. 1955.

"The percentage of exchangeable bone Ca in unashed compact ox bone has been detd. as 33%. From the loss of Ca^{45} ions both from a radioactive soln. and from bone previously equilibrated with Ca^{45} , the results were similar. The time taken for the exchange process to reach equil. depends on the size to which the bone has been ground. For particles passing through a 200-in. mesh the initial rapid exchange is completed in 2-4 hrs." (Chem. Abs. 49: 13394.)

397. ENGFELDT, B., and HJERTQUIST, S. O. Biophysical studies on bone tissue. X. The *in vivo* and *in vitro* uptake of radioactive isotopes and ionic-exchange reactions in bone tissue. *Acta Path. et Microbiol. Scand.* 35: 205-216. 1954.

"The *in vivo* and *in vitro* uptakes of radioactive isotopes (P, Ca, S) in bone tissue, and the capacity of the tissue for ionic-exchange reactions under varying conditions, were studied. An autoradiographic procedure was employed for detg. which structures in the bone tissue take up isotopes. The degree of mineralization of these areas was also studied by means of microradiography. The *in vivo* and *in vitro* uptakes of P^{32} , Ca^{45} , and S^{35} occur in the same structures; namely, the newly laid down, poorly mineralized areas. The uptake of S^{35} differs from that of P^{32} and Ca^{45} in that part of the sulfate goes to org. and part to the inorg. phase, whereas P^{32} and Ca^{45} both go to the inorg. phase. Each of these 3 isotopes shows, both *in vivo* and *in vitro*, a capacity for exchange reactions with ions in the surrounding fluid. Ca^{45} seems to be more firmly fixed to the bone tissue than is P^{32} . S^{35} is less firmly fixed than the others. The explanation may be that the sulfate is incorporated in the bone salt by hetero-ionic exchange, and that in this form of exchange reaction the attachment to the bone salt is less stable. The hypothesis is propounded that the reason why certain structures take up isotopes *in vivo* and *in vitro* lies in the smaller size of the crystallites in newly formed areas of bone tissue. 25 references." (Chem. Abs. 49: 1914.)

398. FALKENHEIM, M., UNDERWOOD, E. E., and HODGE, H. C. Calcium exchange; the mechanism of absorption by bone of Ca^{45} . *Jour. Biol. Chem.* 188: 805-817. 1951.

"Powd. bone ash adsorbed Ca^{45} from an aq. soln. of CaCl_2 without the simultaneous deposition of a proportionate fraction of the total Ca of the soln. This adsorption is adequately explained by assuming that bone Ca exchanged rapidly and reversibly with soln. Ca. About $\frac{1}{2}$ of the Ca of the bone entered into the exchange reaction. Since the same fraction of the bone P is available for exchange, it is assumed that the exchangeable Ca and P, at least in the rapid exchange reaction, represent atoms from the surface of the microcrystals of hydroxylapatite. Ca exchange is exponential, and P exchange is hyperbolic, both *in vitro* and *in vivo*. Fresh bone takes up Ca^{45} slower but a more continuing process that may represent both exchange and recrystn. The Ca exchange was always somewhat greater than the phosphate." (Chem. Abs. 45: 5280.)

399. GOVAERTS, J. Isotopic exchanges and the existence of tricalcium phosphate in bone. *Nature* 174: 831-832. 1954.

" $\text{Ca}_3(\text{PO}_4)_2$ samples were exposed to radioactive Na_2HPO_4 or CaCl_2 solns. The amt. of exchange was detd. At 18° the percentages of exchange of Ca and phosphate ions were similar. At higher temps. this was not true, although the exchange percentages of both increased. A lack of exchange was observed with $\text{Ca}_3(\text{PO}_4)_2$ ignited at

900° and large crystals of hydroxapatite. The results exclude that the exchange concerns absorbed phosphate ions already present in the solid phase when the expt. started. The results do not support the assumption that the principal bone component is hydroxyapatite which absorbs the phosphate to give a Ca/P ratio of 1.94." (Chem. Abs. 49: 4831.)

400. HODGE, H. C., GAVETT, E., and THOMAS, I. The adsorption of strontium at forty degrees by enamel, dentin, and bone and hydroxyapatite as shown by the radioactive isotope. *Jour. Biol. Chem.* 163: 1-6. 1946.
"Sr is adsorbed *in vitro* from SrCl_2 solns. by various calcified tissues in the order: bone, dentine, enamel. The adsorption of Sr by powd. bone is of sufficient magnitude to account for the Sr taken up by bone *in vivo*." (Chem. Abs. 40: 4424.)

401. MINDER, W., and GORDONOFF, T. Model study of uptake of Ca in bones. *Schweiz. Med. Wchnschr.* 83: 825-828. 1953.

"Fresh bone meal takes up Ca^{45} from soln. at first rapidly then more slowly indicating a deeper exchange in the crystal lattice. Ignited bone meal takes up Ca^{45} more slowly, and powd. apatite still more slowly. The evidence confirms the structure suggested by Dallemagne and Brasseur (C.A. 42, 2657f). Loss of Ca^{45} by exchange with a CaCl_2 soln. occurs, but a considerable fraction remains in the bone meal. The exchange ratio agrees with the exchange between blood and bone Ca." (Chem. Abs. 48: 4666.)

402. NEUMAN, W. F. The surface concept of bone metabolism. *Cong. Internatl. de Biochim., 2e Cong. Paris, Résumés Commun.* 1952: 336. 1952.

"A discussion. The enormous surface of the mineral crystallites of bone facilitates surface reactions." (Chem. Abs. 50: 2711.)

403. NEUMAN, W. F., TORIBARA, T. Y., and MULRYAN, B. J. The surface chemistry of bone. VII. The hydration shell. *Amer. Chem. Soc. Jour.* 75: 4239-4242. 1953.

"Considerable amts. of H_2O are intimately assoed. with the crystals of hydroxyl apatite and of bone. This H_2O is only partially removed by high speed centrifugation; this hydration shell does not contain the electrolytes of the bulk soln. and the crystals absorb H_2O in accordance with the Brunauer-Emmett-Teller theory (cf. C.A. 32, 4037⁹). X-ray diagrams of hydrated and unhydrated crystals were the same." (Chem. Abs. 48: 1511.)

404. NEUMAN, W. F., TORIBARA, T. Y., and MULRYAN, B. J. The surface chemistry of bone. IX. Carbonate: Phosphate exchange. *Amer. Chem. Soc. Jour.* 78: 4263-4266. 1956.

"Investigations of a model system (aq. buffer-hydroxyapatite crystals) were conducted to clarify the problem of carbonate fixation in bone. In the model system, bicarbonate was found to penetrate the hydration shells of the crystals and, in addn., to displace phosphate ions from the surfaces of the crystals. Conclusion: These processes could account for the large amts. of CO_2 found in bone and the exchange reaction was probably the more important." (Chem. Abs. 51: 2143.)

405. NEUMAN, W. F., and WEIKEL, J. H., JR. Recrystallization in bone mineral. *N.Y. Acad. Sci. Ann.* 60: 685-695. 1955.

"The removal of radioactive phosphate from soln. by hydroxyapatite occurs by a series of 1st-order reactions: (1) exchange of phosphate between the soln. and the hydration shell; (2) interchange of ions between the hydration shell and the crystal surface; and (3) interchange of surface ions with sub-surface ions. Increase of ionic strength decreases the rate const. of 2 but not of 3. The recrystn. process is an extension of the surface exchange reaction mediated by thermal interchange of ions, rather than soln. and reppn. Studies of 200-g. rats maintained for 70 days on a diet of const. specific activity of Ca^{45}

indicate that much of the Ca^{45} of the femur resulted from the accretion of new mineral. Haversian replacement and the exchange pool accounted for 2.5 and 4%, resp. Recalcn. of Buchanan's data (C.A. 47: 739h) indicates that over 30% of skeletal carbonate is in the exchange pool. The dynamics of Ca metabolism are discussed. 19 references." (Chem. Abs. 49: 12554.)

406. TAYLOR, T. G., MOORE, J. H., and TOMLIN, D. H. Exchange of bone calcium and phosphorus *in vivo*. *Nature* 173: 1137-1138. 1954.

" Ca^{45} and P^{32} were fed for 14-23 days to laying pullets 8 months of age. After laying 3 eggs on a diet adequate in Ca, 4 birds were fed a ration very low in Ca. Two pullets were killed after laying 2 eggs, and 2 after laying 6 eggs, on this diet, and loss of Ca from the skeleton was detd. by assay of the bones. The calcd. percentages of exchange confirmed the conclusion that the incorporation of radioactive tracers into bone minerals by exchange does not occur to such an extent as to preclude their use in studies of bone growth. This is in contrast with the conclusions of Neuman and Riley (C.A. 41, 5599a) and of Harrison and Harrison (C.A. 44, 10868h)." (Chem. Abs. 48: 13008.)

407. WEIKEL, J. H., JR., NEUMAN, W. F., and FELDMAN, I. The surface chemistry of bone. VIII. On the mechanism of ionic exchange. *Amer. Chem. Soc. Jour.* 76: 5202-5207. 1954.

"The ionic exchange properties of bone mineral, as represented by hydroxyapatite (I), were studied under a variety of conditions with P^{32} and Ca^{45} as tracers. The time course of the over-all exchange properties appears to occur in a series of steps corresponding to the phys. location of the exchangeable phosphate groups in the crystals themselves, i.e. the hydration shell, the lattice surface, and interior lattice positions. Aq. $\text{K}_2\text{HPO}_4\text{-CaCl}_2$ (700 cc.) (contg. 5 γ P and 10 γ Ca and adjusted with NaOH to pH 7.2) was stirred at least 24 hrs. with 1 g. I or bone prepn., the mixt. treated with 1-cc. carrier-free P^{32} phosphate (in some runs with Ca^{45} instead), and 1-cc. samples of the filtered mixt. periodically assayed. The resulting data for the exchange of P^{32}O_4 —in soln. for PO_4 —assocd. with I crystals are best interpreted by assuming the rate-dtg. step to be escape or self-diffusion of phosphate ions from the crystal surface to the hydration shell. The exchange expts. with Ca^{45} resulted over a period of 44 days in a 17% exchange, which is much too large to be attributed to surface reactions alone, but rather proceeds within the crystal interior (thermal aging)." (Chem. Abs. 49: 3615.)

408. WOJTA, H. Surface-chemical processes as an essential part of the mineral metabolism in the bones. *Klin. Wchnschr.* 32: 1025-1030. 1954.

Calcification Mechanisms

409. BARBIERI, E. Some relations between pancreatic B-cells and the metabolism of epiphyseal cartilage. I. Adenosinetriphosphate concentration in the cartilage of young alloxan-diabetic rats. *Experientia* 13: 370-371. 1957.

"The concn. of adenosinetriphosphate in epiphyseal cartilage of alloxan-diabetic rats was 40% less than in normal rats." (Chem. Abs. 52: 3056.)

410. BARBIERI, E. Some relations between pancreatic B-cells and the metabolism of epiphyseal cartilage. II. Cartilage cocarboxylase activity of young alloxan-diabetic rats. *Experientia* 13: 371-372. 1957.

"Cocarboxylase activity was about 45% lower in the alloxan-diabetic rats than in normal rats." (Chem. Abs. 52: 3056.)

411. BEVELANDER, G. A study of calcification in mollusks with special reference to the use of phosphorus³² and calcium⁴⁵. *N.Y. Jour. Dentistry* 21: 305-308. 1951.

"Similarities in calcification of mollusk shells and

mammalian teeth are pointed out." (Chem. Abs. 45: 9754.)

412. CARTIER, P., and PICARD, J. Mineralization of ossifiable cartilage. II. The ATPase system of cartilage. Soc. de Chim. Biol. Bul. 37: 661-675. 1955.

"The enzymatic characters of cartilage mineralization in presence of ATP are discussed. The activity is enhanced by Mg ion, has its optimum at pH 8 and is independent of aerobic or anaerobic conditions. The enzyme in question is not extractable and is distinct from alkaline phosphatase, as shown by the fact that it is unaffected by inhibitors of the latter enzyme and differs from it in distribution." (Excerpta Med. 10: 1147.)

413. DiSTEFANO, V., and NEUMAN, W. F. Ca complexes of ATP and ADP and their significance in calcification *in vitro*. Jour. Biol. Chem. 200: 759-763. 1953.

"Tracer studies with Ca^{45} and ion-exchange resins demonstrated conclusively that Ca forms relatively undissociated complex ions with adenosine triphosphate (ATP) and adenosine diphosphate. The phosphatases present in rachitic bone cartilage liberate only small amts. of inorg. phosphate from ATP. These results explain the inhibitory effect of ATP on calcification *in vitro*." (Chem. Abs. 47: 8141.)

414. EGG-LARSEN, N. Experimental study on growth and glycolysis in epiphyseal cartilage of rats. Acta Physiol. Scand. 38 (sup. 128): 1-77. 1956.

"A review and experimental study of water, ash, lactic acid, glycogen content and growth of the tibia of young rats; of lactic acid formation in epiphyseal cartilage slices and homogenates, before and after addition of purified enzyme prep." (Internatl. Abs. Biol. Sci. 7: 1042.)

415. FRIDENSHTEIN, A. Y. Histochemistry of bone tissue and some problems in skeletal histogenesis. Uspekhi Sovremennoi Biol. 42: 249-258. 1956.

A review with 55 references.

416. GOLDENBERG, H., and SOBEL, A. E. Calcification. IX. Influence of alkaline earths on survival of calcifying mechanism. Soc. Expt. Biol. and Med. Proc. 81: 695-698. 1952.

"Small amts. of Ca or Sr exerted a protective effect against deterioration of the calcifying mechanism present in rachitic bone cartilage slices. Mg and Ba had no such effect. Be, Mn, Co, and Ni inactivated the system. Beryllium inactivation was partially prevented by phosphate." (Chem. Abs. 47: 4502.)

417. GUTMAN, A. B. Enzymes and templates in bone salt formation. Amer. Jour. Med. 17: 585-586. 1954.

"An editorial dealing with the relative roles of physico-chemical activity versus the living cell in the deposition of bone salt. It is pointed out that there is good evidence that basic calcium phosphate is laid down in osteoid by crystallization, but the extent to which enzymes, hormones and vitamins regulate and modify this is not well understood at the present." (Excerpta Med. 8: 5204.)

418. HEIMER, C. B., and others. Calcification. XV. *In vitro* calcification of rachitic bone cartilage of thyroparathyroidectomized rats. Soc. Expt. Biol. and Med. Proc. 87: 13-16. 1954.

H. Maslow, A. E. Sobel, and D. M. Grayzel, joint authors.

"Rickets was produced in rats thyroparathyroidectomized at age 21-23 days as readily as in controls. Both groups were on a rachitogenic diet with a Ca/P ratio of 10.3. X-ray and histological examn. and blood chem. analysis for Ca and phosphate were comparable in both groups of rachitic animals. Rachitic bone cartilage from either group calcified to the same degree *in vitro*. Under the conditions of the expt. neither the secretions from the parathyroid glands nor any enzyme system such as that

involving bone citrogenase are essential for calcification *in vitro*." (Chem. Abs. 49: 1902.)

419. HENRICHSEN, E. Alkaline phosphatase and calcification in tissue cultures. Expt. Cell Res. 11: 403-416. 1956.

"The relationship between alkaline phosphatase, calcification, and cellular alteration in chick heart fibroblast tissue cultures is described. In cells beginning to degenerate, alkaline phosphatase is present without calcification, followed by slight calcification localised in single cells. In the third stage, alkaline phosphatase is absent, but calcification is more pronounced and may later develop outside the cell boundaries. It is concluded that the action of alkaline phosphatase inside a living cell will not cause calcification, initial calcification occurring when alkaline phosphatase is liberated from a damaged, dying or dead cell containing phosphatase. Further calcification proceeds without phosphatase." (Internatl. Abs. Biol. Sci. 6: 2339.)

420. HIATT, H. H., MARKS, P. A., and SHORR, E. Effects of inhibitors on calcium deposition *in vitro*. Jour. Biol. Chem. 204: 187-195. 1953.

"Ca deposition in epiphyseal cartilage *in vitro* is influenced adversely by both high and low temps. The failure of $2,4-(\text{O}_2\text{N})_2\text{-C}_6\text{H}_3\text{OH}$, anaerobiosis, azide, and malonate to interfere with endochondrial calcification *in vitro* suggests that this process is not dependent upon either aerobic phosphorylation or other oxidative processes. Alk. phosphatase activity is required for calcification, at least when P is made available in the calcifying medium only as phosphoric ester. Ca deposition depends upon enzymic processes." (Chem. Abs. 47: 12553.)

421. HOLT, L. E., JR., PIERCE, J. A., and KAJDI, C. N. The solubility of the phosphates of strontium, barium, and magnesium and their relation to the problem of calcification. Jour. Colloid Sci. 9: 409-426. 1954.

"The soly. of the orthophosphates of Ba, Ca, Sr, and Mg were detd. by titrating $0.1M \text{H}_3\text{PO}_4$ at 38° with solns. of the alk. earth hydroxides and analyzing the ppts. formed for metal:P ratio. The interaction of H_3PO_4 with $\text{Mg}(\text{OH})_2$ produced only $\text{Mg}_3(\text{PO}_4)_2$. The solid phase formed from H_3PO_4 and $\text{Ba}(\text{OH})_2$ was BaHPO_4 at all acidities up to 2 equivs. acid per equiv. of base. The solid phase formed from H_3PO_4 and $\text{Sr}(\text{OH})_2$ was SrHPO_4 at acidities between 1.1 and 1.85 equivs. acid per equiv. of base, with steadily increasing Sr:P ratio at higher acidities. The soly. products (pK), detd. as a function of ionic strength (μ) were: $\text{Mg}_3(\text{PO}_4)_2$, $27.2-29 \mu^{0.5}$; BaHPO_4 , $7.56-8.4 \mu^{0.5}$; SrHPO_4 , $7.06-8.1 \mu^{0.5}$, while for $\text{Ba}_3(\text{PO}_4)_2$, $pK=29.34$ at $\mu=0.0008$ and for $\text{Sr}_3(\text{PO}_4)_2$, $pK=27.8$ at $\mu=0.0035$. Since the tribasic orthophosphates of Ba, Mg, and Sr are considerably more sol. than is $\text{Ca}_3(\text{PO}_4)_2$, Ba, Mg, and Sr can compete successfully with Ca in calcification processes only if they are present at concns. well above those attained by Ca in biol. fluids." (Chem. Abs. 49: 1409.)

422. IRVING, J. T., and WEINMANN, J. P. Experimental studies in calcification. VI. Response of dentin of the rat incisor to injection of strontium. Jour. Dent. Res. 27: 669-680. 1948.

Sr produced changes in dentin in a definite pattern consisting of (a) a calciotraumatic line, (b) a hypocalcified layer, and (c) a hypercalcified layer of dentin.

423. LONTIE, P. Skeletal distribution of radiocalcium in the adult dog. Rev. Belge de Path. et de Méd. Expt. 23: 118-125. 1953.

"The fixation of radiocalcium injected in adult rabbits was measured in as many parts of the long bones as possible. The results are given in a table, in which the same arbitrary value for each animal was assigned to the middle fifth of the right humerus. The table shows that the proportional distribution of the radioactivities in a given bone does not change significantly in a period of about 200 days." (Author's summary.)

424. MARKS, P. A., HIATT, H. H., and SHORR, E. Factors influencing deposition of calcium and strontium in cartilage *in vitro*. Jour. Biol. Chem. 204: 175-185. 1953.

"A technique is described for study of the deposition of Ca and Sr *in vitro* in epiphyseal cartilage of rachitic rats. The deposition of both Sr and Ca *in vitro* occurs in the zone of hypertrophic cells of the epiphyseal cartilage plate. Phlorizin and iodoacetamide inhibit calcification and stromatification of cartilage *in vitro*. The use of a technique for staining glycogen in surviving cartilage provides further evidence for a relation between glycogen and Ca and Sr deposition in cartilage *in vitro*. Cyanide does not inhibit either Ca or Sr deposition in cartilage *in vitro*; oxidative processes cannot be assigned an indispensable role in these depositions." (Chem. Abs. 47: 12553.)

425. MARKS, P. A., and SHORR, E. Factors which regulate the deposition of calcium and strontium in rachitic cartilage *in vitro*. Conf. on Metabolic Interrelat. Trans. 2: 191-202. 1950.

"Phosphorylative glycolysis plays a major role in calcification and stromatification. However, neither cyanide nor malonate inhibited deposition of the cations." (Chem. Abs. 45: 5276.)

426. NISHIYAMA, Y. Histochemical studies on pathological calcification. Keizyo Jour. Med. 2: 59-71. 1953.

"Tissues removed at autopsy and containing sites of pathological calcification were sectioned and stained by various procedures, including Kossa's AgNO₃ method (I) (Beitr. z. Path. Anat. 29: 163-202 (1901)) for calcium phosphate and Nishiyama's modification of Kossa's method (II), whereby the Ca salts are converted to oxalate and the Ca is replaced by Ag, which turns black on exposure to sunshine. Some of the calcified sites were stained by both I and II, some only by II. The reactions given by the Van Gieson and the Mallory stains suggested protein degeneration at the site of calcification, especially in those sites stained only by II. Positive reactions were given by the periodic acid-Schiff reagent, by Hale's colloidal Fe reagent, and by Feyrter's stain for metachromasia, all of which suggest the presence of mucopolysaccharides. Weigert's fibrin stain was positive, especially in sites stained only by II. The calcified elastic fibers showed swelling, filaments, and granules. The Sudan III reaction was negative. Conclusion: The mucopolysaccharides, by influence of some tissue damage, lose their colloidal property, precipitate, and combine with ionized Ca to form a mucopolysaccharide-Ca complex. This condition preceded the deposition of inorganic Ca." (Author's summary.)

427. OWEN, M. Measurements of the variations in calcification in normal rabbit bone. Jour. Bone and Joint Surg. 38-B: 762-769. 1956.

428a. PICARD, J., and CARTIER, P. Incorporation of radiophosphorous in the long bones of normal and rachitic rats. Cong. Internatl. de Biochim., 3^e Cong. Brussels, Résumés Commun. 1955: 138. 1955.

"Radioactive P was administered to young rats (normal and rachitic) in the form of inorg. orthophosphates, phosphoric esters, pyrophosphates, and adenosinetriphosphate. Radioactivity (detd. 2, 4, and 24 hrs. after injection) was strongest in the regions of most active mineralization (metaphysis and epiphysis) and weakest in the diaphysis. After injecting I or glucose-1-phosphate, the activity of zones already mineralized was greater in normal than in rachitic rats. When pyrophosphates, adenosinetriphosphate, or glucose-6-phosphate was given, activity was more intense in all portions of the bones of rachitic than of normal rats. P metabolism is more labile in rachitics. The *in vivo* results confirm the *in vitro* results." (Chem. Abs. 50: 14077.)

428b. PICARD, J., and CARTIER, P. Mineralization and metabolism of the cartilage in normal and rachitic rats. Cong. Internatl. de Biochim., 3^e Cong. Brussels, Résumés Commun. 1955: 138. 1955.

"P is utilized *in vitro* by the ossifiable cartilage of normal young rats about equally well from inorg. orthophosphates (I) providing PO₄ ion, from phosphoric esters (II), and from pyrophosphates (III) from adenosinetriphosphate (IV). In predominantly anaerobic metabolism, glucose and its esters are utilized more rapidly than glycogen. Glucose in the medium hinders the utilization of IV. Rachitic cartilage assimilates P from I, II, and III more intensely than does normal cartilage, although the III from IV are not fixed directly but as I. Rachitic cartilage has a weaker respiration than normal cartilage, but has a much higher glycolytic and glycogenolytic activity. Its intense carbohydrate catabolism (assocd. with the disappearance of glycogen from sections *in vitro*) explains the differences in P metabolism." (Chem. Abs. 50: 14077.)

429. PICARD, J., and CARTIER, P. Mineralization of ossifiable cartilage. V. Glycolysis and glycogenolysis in cartilage. Soc. de Chim. Biol. Bul. 38: 697-715. 1956.

"Biochemical study of the various stages of ossification suggests a relationship between mineralization and carbohydrate metabolism of cartilage. To throw light on this relationship, the glycolytic and glycogenolytic activity of cartilage slices was measured by chemical and manometric methods, along with their mineralization in *in-vitro* experiments. Cartilage metabolism is primarily anaerobic. The glycolytic mechanism has been further examined with identification of the phosphorylated intermediates by chromatography and with blocking of the glycolysis at various stages of inhibitors. During mineralization, respiration in the cartilage slices is weak but they actively metabolize glucose and less rapidly glycogen. The glycolysis of cartilage is important even without added ATP. But the presence of glucose in increasing amounts interferes considerably with cartilage mineralization by ATP." (Excerpta Med. 10: 1148.)

430. PICARD, J., and CARTIER, P. Mineralization of ossifiable cartilage. VI. Effect of phosphates from carbohydrate breakdown on the metabolism and mineralization of cartilage. Soc. de Chim. Biol. Bul. 38: 697-715. 1956.

"The phosphate compounds of carbohydrate breakdown are actively used by cartilage which has glycolytic enzymes of the Meyerhof scheme. With no direct effect on cartilage mineralization, the phosphate compounds may contribute to it when used in conjunction with ATP by a process the character of which is discussed. The presence of excess of phosphate compounds in the medium causes antagonism between the glycolysis and mineralization of ATP which is not observed when certain inhibitors of glycolysis are added." (Excerpta Med. 10: 1148.)

431. ROCK, T., and RABOTTI, G. Mineralization in endochondral osteogenesis. Biol. Latina 7: 598-608. 1954.

"The fixation of P and Ca by sections of cartilage of epiphyses of the femur and tibia of ox fetuses of 7 months was investigated (histochemical reaction of Von Kossa and determinations by the method of Siwe). Amounts of P and Ca of 600-740 and 780-965 γ /100 mg., respectively, were found with Ca/P ratio of 1.30." (Author's summary.)

432. RYGH, O. Chemical data on calcium metabolism in the organism and in the teeth. II. Norske Tandlaegeforening Tid. 63: 256-260. 1953.

"It is emphasized that the bone and tooth substance must be regarded as a living intracellular substance in const. exchange with sol. Ca salts and phosphate and carbonate ions of the serum. In this exchange the trace elements Ba and Th also seem to play an important role, as well as the citrates. Enzymes are also involved in the formation and decompn. of bone and tooth substance." (Chem. Abs. 49: 14134.)

433. SAVCHUCK, W. B. Effects of strontium and fluoride on the repair of unreduced humeral fractures in

the adult rat. Jour. Bone and Joint Surg. 39-A: 140-152. 1957.

"Adult rats (12) were given IP injections of Sr^{89} , 1.5 mc, at regular intervals from 2 to 12 weeks after experimental fractures of the left humerus. Controls (12) were treated with similar doses of radioactive strontium plus 2 mg. of NaCl. The bones were studied histologically, chemically for total bone ash, and mechanically for breaking strength by means of a new technique. The most extensive uptake of strontium occurred about 4 weeks after the fracture. Fluoride intake did not alter the rate of strontium deposition in the mineral of new bone. The method of measuring the breaking strength of fractures was accurate to $\pm 6\%$. There was no correlation between breaking strength, X-ray, histological structure, or mineral content with respect to strontium or fluoride." (Biol. Abs. 31: 16776.)

434. SCIORTINO, G. B., and SCILLIERI, G. Glycolysis of growing cartilage. Biochim. Appl. 4: 232-240. 1957.

"By the technique of Mazza and Lenti (Arch. sci. biol., 24: 203 (1938)), the glycolytic activity of the growing cartilage of young calves was studied. The extn. of the cartilage homogenate with Ringer solns. had no influence on the formation of lactic acid from glucose. The addn. of monoiodoacetate, o-iodosobenzoate, iodoacetamide, or p-chloromercuribenzoate to the extpl. system blocked lactic acid formation in the system with homogenate not extd. with Ringer soln., but not that of the Ringer-extd. homogenate. The addn. of ethylenediaminetetraacetic acid inhibited the former (and not the latter) system, unless Mg^{++} was added to it. The above suggests that in growing cartilage a mechanism of lactic acid formation from glucose is not the Embden-Meyerhof scheme." (Chem. Abs. 52: 4786.)

435. SHORR, E., and CARTER, A. C. Strontium as an adjuvant in the treatment of post-menopausal osteoporosis. In Conference on Metabolic Aspects of Convalescence, 16th Meeting Transactions, p. 121-132. New York, Josiah Macy Jr. Foundation, 1947.

436. SOBEL, A. E. Local factors in the mechanism of calcification. N.Y. Acad. Sci. Ann. 60: 713-732. 1955.

"The relation between the fluid and solid compn. of the mineralized tissues can be expressed by the equation $(\text{CO}_3^{2-}/\text{PO}_4^{3-})_{\text{solid}} = \text{K}(\text{CO}_3^{2-}/\text{PO}_4^{3-})_{\text{soln.}} + b$. K is influenced by vitamin D and possibly the "local factor", and b is detd. by the "local factor". Evidence is presented that teeth susceptible to caries have a high carbonate content. A comparison of the mineral compn. of enamel, dentine, and bone, and comparison of the compn. of these tissues in the cotton and Wistar rat indicate inherent variations in the operation of the "local factor". Evidence is presented suggesting that a complex of chondroitin sulfate and collagen in a specific configuration may be the "local factor" in pre-osseous cartilage. 65 references." (Chem. Abs. 49: 12554.)

437. SOBEL, A. E., and BURGER, M. Calcification. XIV. Investigation of the role of chondroitin sulfate in the calcifying mechanism. Soc. Expt. Biol. and Med. Proc. 87: 7-13. 1954.

"Toluidine and protamine, like inorg. cations, produce a reversible inactivation of the mechanism of calcification of rat-bone sections *in vitro*. This inactivation is a function of inhibitor: Ca ratio. Up to a concn. of about 15 meq./l., Ca^{++} in the dye soln. increases the intensity of metachromatic staining. Above this concn. there is a gradual decrease of metachromasia. Under certain conditions described the calcifiability of bone sections parallels metachromasia; but it is possible, by raising the Ca^{++} concn., to eliminate metachromasia while increasing calcifiability, or by treatment, with certain protein denaturants, to destroy calcifiability while enhancing metachromasia. Synthetic chondroitin sulfate-collagen complexes behave like rachitic bone cartilage with regard to metachromasia and calcifiability. Results obtained with chondroitin sulfate, collagen, and their complexes indicate that such

complexes behave in a manner homologous to the actual calcification mechanism and thus support the hypothesis that they are involved in calcification." (Chem. Abs. 49: 1902.)

438. SOBEL, A. E., and BURGER, M. Influence of ATP on calcification *in vitro*. Fed. Proc. 16: 252. 1957.

"Rachitic bone sections treated for 2 hours at 37°C . with 1 mM ATP containing 25 to 75 mM of Ca^{++} at pH 7.1 to 7.3 calcified *in vitro* in inorganic media at $\text{Ca} \times \text{P}$ products of 20 (4 mg. percent Ca, 5 mg. percent P) and 10 (2 mg. percent Ca, 5 mg. percent P). This calcification included both the hypertrophic cartilage and the bare osteoid. Control sections, treated with Ca^{++} , or fresh sections, under the same conditions, did not exhibit calcification *in vitro*. These control sections calcified at $\text{Ca} \times \text{P}$ products of 40 (8 mg. percent Ca, 5 mg. percent P), or higher. This calcification did not extend into the bare osteoid but was limited to the hypertrophic cartilage. When ATP was placed in the medium employed for calcification *in vitro*, inhibition of calcification *in vitro* was obtained even at a $\text{Ca} \times \text{P}$ product of 50 (10 mg. percent Ca, 5 mg. percent P). Theoretically the formation of a solid from an undersaturated solution should require some form of energy for concentrating the ions forming the solid, whereas in a saturated or supersaturated solution, nuclei would be required, the formation of which may be aided by appropriate forms of energy. Whether preliminary treatment with ATP enhances the activity of the calcifying mechanism by providing energy for one or both of the aforementioned postulates or by direct formation of nuclei not involving energy is the subject of further investigation." (Author's abstract.)

439. SOBEL, A. E., and others. Calcification. XVIII. Lack of correlation between calcification *in vitro* and glycolytic enzymes. Soc. Expt. Biol. and Med. Proc. 96: 32-39. 1957.

M. Burger, B. C. Deane, H. G. Albaum, and K. Cost, joint authors.

"Glycolytic enzymes (I) and their relation to *in vitro* calcification of the preosseous cartilage of rachitic rat bone tissue were studied. The findings indicate that although I are present in tissue kept frozen at -25° for 2 weeks, the ability to calcify *in vitro* is lost. However, if the tissue is treated first with CaCl_2 soln. and then stored in the deep freeze, the I are absent or nearly so while the calcifying mechanism remains almost intact. Bone sections heated at 65° and then treated with CaCl_2 retain their ability to calcify despite the destruction of the I by the heat treatment. Demineralization of bones (by ethylenediaminetetraacetate) causes loss of glycolytic enzyme activity. If the demineralized bones are treated with chondroitin sulfate and then with CaCl_2 , the calcifying mechanism is restored but not the glycolytic activity. It thus appears that I are not part of the min. system required for calcification." (Chem. Abs. 52: 1307.)

440. SOBEL, A. E., and others. Mechanism of calcification. Fed. Proc. 15: 358. 1956.

M. Burger, J. Samachson, and N. Slovik, joint authors.

"Bones were demineralized with ethylenediaminetetraacetic acid (EDTA). When treated with chondroitin sulfate, followed by calcium chloride, such bones remodeled in a calcifying solution. A second method of inducing mineralization was to treat bones with calcium chloride, followed by sodium phosphate. When the order of treatment was reversed, mineralization did not take place. From these studies and from our studies with inhibitors, the following picture of the calcifying mechanism emerges. The calcium-collagen-chondroitin sulfate complex is able to initiate the nuclei of crystallization. These nuclei undergo crystal growth to form apatite. Treatment with calcium followed by phosphate produces these nuclei and thus remineralization can take place without the nuclei-producing mechanism that appears to involve a collagen chondroitin sulfate complex. The collagen appears to be a specific protein." (Author's abstract.)

441. SOBEL, A. E., and GOLDENBERG, H. Calcification. V. Influence of fluoride and cyanide ions in the presence and absence of magnesium. Soc. Expt. Biol. and Med. Proc. 78: 719-723. 1951.

"Fluoride and cyanide are effective inhibitors of calcification of rachitic cartilage in the presence of adequate amts. of Mg, but not in its absence." (Chem. Abs. 46: 2686.)

442. SOBEL, A. E., GOLDENBERG, H., and HANOK, A. Calcification. IV. Influence of strontium and magnesium ions on calcification *in vitro*. Soc. Expt. Biol. and Med. Proc. 78: 716-718. 1951.

"The marked inhibition of calcification of rachitic cartilage *in vitro* by Sr occurs only in the presence of Mg." (Chem. Abs. 46: 2686.)

443. SOBEL, A. E., and HANOK, A. Calcification. VII. Reversible inactivation of calcification *in vitro* and related studies. Jour. Biol. Chem. 197: 669-685. 1952.

"The reversible inactivation of calcification *in vitro* of the hypertrophic epiphyseal cartilage was demonstrated. When rachitic bone sections were shaken with BeCl_2 , MgCl_2 , NaCl , or SrCl_2 , in the presence of 150 meq. of CaCl_2 , calcification *in vitro* was inactivated. On subsequent shaking with CaCl_2 , without inactivating ion this inactivation was reversed and calcification took place *in vitro*. Ions in combination behave differently from the same ions by themselves in the calcification of bone sections *in vitro*. Ni in crit. concn. decreased the inactivation of calcification *in vitro* by Be, and K in crit. concn. decreased the inactivation of calcification *in vitro* by Na. Ni and K were not themselves inactivators at these concns. Mg increased the inhibition of Ca *in vitro* by Sr. Boiling bone sections in distd. water of CaCl_2 solns. inactivated the calcification mechanism. Subsequent shaking of the boiled sections with 150 meq./l. of CaCl_2 reactivated the calcifying mechanism in the case of the water-boiled sections, but not in the case of the CaCl_2 -boiled sections. Combination of Ca with some constituent of the ossifying matrix is an essential preliminary step in the mineralization process. Chondroitin sulfate may be the target of the inactivating and reactivating ions." (Chem. Abs. 47: 192.)

444. SOBEL, A. E., NOBEL, S., and HANOK, A. Reversible inactivation of calcification *in vitro*. Soc. Expt. Biol. and Med. Proc. 72: 68-72. 1949.

"Reversible inactivation of calcification *in vitro* of hypertrophic epiphyseal cartilage can be demonstrated. When rachitic bone sections are shaken with Ca-free solns. of SrCl_2 or NaCl , calcification is inhibited but is resumed when the bone sections are shaken with a CaCl_2 soln. In addn. inactivation takes place with 0.5 milliequiv. of CuCl_2 in presence of 150 milliequivs. of CaCl_2 , but on subsequent shaking with a CaCl_2 soln. contg. no Cu, reactivation takes place." (Chem. Abs. 44: 1182.)

445. THOMAS, W. C., JR., CONNOR, T. B., and HOWARD, J. E. Some physicochemical aspects of calcification *in vitro*. Johns Hopkins Hosp. Bul. 99: 287-295. 1956.

"Using standard techniques for the study of calcification *in vitro* of rachitic rat cartilage, the experiments reported are believed to demonstrate that, once deposition of mineral apatite has been initiated, further deposition will occur even in solutions containing lower concentrations of Ca and P than are necessary for initiation of the process. This was demonstrated by: (1) initiation of calcification *in vitro* (using for brief periods of time concentrations of Ca and P known to produce calcification and following this by incubation in solutions of lower Ca concentrations); and (2) after inducing slight calcification *in vivo*, finding that calcification would continue *in vitro* in solutions with concentrations of Ca and P which would not have produced calcification in fully rachitic cartilage. Possible application of these observations to the healing process in human rickets is discussed." (Excerpta Med. 10: 2472.)

446. VAN HEUSDEN, E. G. General aspects of bone calcification. Jour. Belge de Méd. Phys. et de Rhumatologie 11: 102-106. 1956.

447. WADHWANI, T. K. Mechanism of calcification. Indian Chem. Soc. Jour. 31: 372-376. 1954.

"The initial ppt. of apatite within a calcifying cell absorbs or exchanges ions with the plasma to produce the final bone salt." (Chem. Abs. 49: 7091.)

448. WILBUR, K. M., and JODREY, L. H. Studies on shell formation. I. Measurement of the rate of shell formation using Ca^{45} . Biol. Bul. 103: 269-276. 1952.

"The rate of shell formation in the oyster *Crassostrea virginica* Gmelin has been determined by measurements of Ca^{45} deposited by oysters placed in sea water containing Ca^{45} . The experiments were carried out at Beaufort, N.C., during May and June at 21.2 to 25.4° C. Radioactivity measurements were made directly on the inner shell surface. The mean amount of deposition was directly proportional to the time of exposure to Ca^{45} for 8, 16, and 24 hours. Growth increments occurring in 4 hours were measurable. Individual variation in the rate of deposition was marked. The mean rate of deposition in the posterior region of the shell was approximately twice that in the center and anterior regions. Within a general region local areas may exhibit a still greater difference in rate. From the average radioactivity per unit area of shell surface the total amount of CaCO_3 deposited in a given period can be calculated. Shell from which all tissue had been removed became increasingly radioactive in sea water containing Ca^{45} as a result of exchange. The magnitude of exchange was relatively very small as compared to the active deposition by the oyster. Advantages and limitations of the isotope method for measurements of growth are discussed." (Author's summary.)

Strontium Rickets

449. CHAUCHARD, P., MAZOUÉ, H., and LECOQ, R. Paradoxical effects of addition of strontium carbonate to some rachitic diets. Soc. de Biol. [Paris] Compt. Rend. 138: 948-949. 1944.

"The addition of 2% of SrCO_3 to a rachitic diet contg. Ca lactate makes young rats nonresponsive to the anti-rachitic action of sunlight; but if the Ca lactate is completely replaced by SrCO_3 , this inhibiting action is not evident and sunlight has the usual antirachitic action. The addn. of 2% of SrCO_3 to an alk. rachitic diet (Randoin-Lecoq rachitic diet with 3% of NaHCO_3 added) prevents all osseous and chronaxic symptoms of rickets in rats kept either in darkness or daylight." (Chem. Abs. 40: 1564.)

450. FOLLIS, R. H., JR. Bone changes resulting from parenteral strontium administration. Fed. Proc. 14: 403. 1955.

"That rickets will develop when strontium (Sr) is included in the diet of experimental animals is well recognized. The pathogenesis of the rachitic change has usually been explained by abnormal calcium-phosphorus ratios in the diets employed. When diets containing SrCO_3 at levels of 2 percent or 4 percent and normal in calcium and phosphorus composition are fed to rats, conspicuously wide borders of osteoid appear in the shaft after only a few days. Such increases in bone matrix contrast with a lack of change in the epiphyseal cartilage. On diets adequate in calcium and phosphorus content the intraperitoneal administration of Sr as the chloride at levels of 6-18 mg./100 g. body weight promptly leads to similar and marked changes in the bones of young as well as adult rats. Sr administration appears to stimulate the activity of periosteal and endosteal cells. In addition, as one would expect from *in vitro* observations, Sr appears to affect the calcification mechanism. The stimulatory effect of parenteral Sr may be demonstrated in rats whose bone growth has been inhibited or stopped by partial or complete caloric restriction. Similarly Sr also appears to stimulate the formation of excess osteoid in the early stages of healing fractures of the tibia. As one might

expect from the above, decrease in ash is found in the bones of rats receiving Sr parenterally. Data dealing with inorganic composition of the sera are presented." (Author's summary.)

451. LECOQ, R., CHAUCHARD, P., and MAZOUÉ, H. Is dystrophic rickets, produced by addition of SrCO_3 to the customary rachitic diets, resistant, as believed, both to ultraviolet irradiation and to vitamin treatment? Soc. de Biol. [Paris] Compt. Rend. 137: 444-445. 1943.

"Rats were kept in the dark and given a rachitogenic diet contg. no vitamin D, to which 2% of SrCO_3 had been added. A dystrophic rickets developed which was not modified by frequent ultraviolet irradiation for short periods, but which was ameliorated or cured by administration of vitamin D (fish-liver oil), calciferol, or by addn. of 15% of lactic acid or 30% or more of wheat germ to the diet." (Chem. Abs. 39: 2785.)

452. LOEW, O. Strontium and the physiological function of calcium. München. Med. Wehnschr. 79: 718. 1932.

453. MOURGUE, M. Biochemical investigation on the osteolysis during strontium rickets. Jour. de Physiol. et Path. Gén. 37: 1358-1361. 1939-40.

"Rats were given a rachitogenic diet at which 2% of SrCO_3 was added. This caused decalcification of the whole skeleton, especially of the epiphyseal parts of the bones. This decalcification probably takes place at the cost of the mineral reserves of the skeleton." (Chem. Abs. 44: 4137.)

454. ROCHE, A., and MOURGUE, M. Strontium rickets and demineralization of the long bones in adult rats. Soc. de Biol. [Paris] Compt. Rend. 130: 1136-1138. 1939.

"Adult rats (175 g.) did not develop rickets on the Pappenheimer and other rachitogenic diets. When they were placed on the Pappenheimer no. 85 diet to which 2% of SrCO_3 had been added there was a loss of Ca from all parts of the leg bones. The loss was slightly greater from the epiphyses than from the shafts. Sr phosphate was excreted in the feces." (Chem. Abs. 33: 5453.)

455. SCHMIDT, H. J. Calcification disturbances caused by injection and feeding of strontium. Deut. Zahnärztliche Ztschr. 4: 1363-1372. 1949-50.

"Although Sr cannot replace Ca in the process of mineralization of the teeth, nevertheless it does influence such mineralization. This was demonstrated on the incisors of rats which had been fed Sr. Bibliography of German and American literature." (Chem. Abs. 46: 11359.)

456. SHORR, E., and CARTER, A. C. Usefulness of strontium as an adjuvant to calcium in the remineralization of the skeleton in man. Hosp. Joint Dis. Bul. 13: 59-66. 1952.

"Sr lactate (6.4 g.) daily, equiv. to 1.75 g. Sr is sufficient to be retained and is well tolerated over several yrs. of administration. The retention of Sr is augmented by vitamin D, estrogens, and androgen similarly to that of Ca. When given in equal amts. with Ca, there is greater retention of Sr, and when the max. Ca retention has been reached the Sr increases the Ca retention. That is, the deposition of Ca plus Sr is greater than the total Ca storage which can be achieved with Ca alone. This combination increases the rate of remineralization of the skeleton, and max. retention of the combination is increased by vitamin D, estrogens, and androgens. It is suggested that Sr be used to measure mineral salt turnover in the bone. 28 references." (Chem. Abs. 47: 728.)

457. SOBEL, A. E., COHEN, J., and KRAMER, B. Nature of injury to calcifying mechanism in rickets due to strontium. Biochem. Jour. 29: 2640-2645. 1935.

In vitro calcification with Sr and Ca rickets showed that the calcifying power of bones of animals with Sr rickets was diminished but not destroyed. Injury to the calci-

fying mechanism by Sr was reversible both in vitro and in vivo.

458. SOBEL, A. E., COHEN, J., and KRAMER, B. Phosphatase activity and calcification in strontium rickets. Biochem. Jour. 29: 2646-2650. 1935.

No relationship was found between loss of calcifying and phosphatase activity in bones of animals suffering from Sr rickets.

459. SUMI, M., MATUMIYA, S., and SATO, K. Histological studies of bone changes brought about by strontium carbonate. Inst. Phys. and Chem. Res., Japan, Bul. 18: 982-991. 1939.

"Rats fed on diets contg. 4% SrCO_3 develop rachitic symptoms more rapidly when Ca:P = 1:5.81 than when Ca:P = 1:0.667." (Chem. Abs. 35: 3712.)

Tissue Composition

460. ANDREATTA, C., and FORNI, I. The mineral and organic constituents of bone and human cartilage. Bul. delle Sci. Med. 125: 365-370. 1953.

Intact and unheated bones were shown to contain apatite. Spectrograms of powdered or heated (800°) bones differed only as to the amount and size of the apatite crystals. Spectrograms of demineralized bones were equal to those of human natural cartilage. A structural relation exists between apatite crystals and the collagen fibers of the bone matrix.

461. ANTHONY, A., and PARSONS, J. Variation in normal sodium, potassium, and calcium levels in Wistar albino rats. Science 125: 881-883. 1957.

"The effect of time of sampling and diurnal variation of Na, K, and Ca levels of serum from two strains of Wistar albino rats, identified as CF and SF strains, was detd. Alldetns. were by the method of Kingsley and Schaffert (C.A. 48: 2805a) on a flame spectrophotometer. For strain CF sampled at 1-3 p.m. the mean values and SD for 109 detns., in meq./l. were: Na 151.0 ± 4.4 , K 5.54 ± 0.62 , Ca 4.93 ± 0.27 . For 72 samples from SF strain which were sampled at random intervals the values were Na 157.2 ± 4.2 , K 6.11 ± 0.56 , Ca 5.41 ± 0.30 . By using 2 groups of SF strain it was found that serum Na was significantly lower at 11 a.m. than at 11 p.m., the K level was higher in the morning and the Ca levels were unaffected by time of sampling. Likewise variations were found when blood was taken at weekly intervals. In 4 detn. on 24 animals the Na ranged from 146.6 to 154.8 and the K from 5.27 to 5.59 meq./l. There was no significant difference in serum ion level of male and female rats." (Chem. Abs. 51: 13117.)

462. ASARI, T. Geochemical distribution of Sr. VI. Sr contents of bones. Chem. Soc. Japan Jour. 71: 12-13. 1950.

463. ASARI, T. Geochemical distribution of Sr. VII. Sr in shells. Chem. Soc. Japan Jour. 72: 156-158. 1950.

464. ASARI, T. Geochemical distribution of Sr. VIII. Sr contents in fossil of meretrix. Chem. Soc. Japan Jour. 72: 205-208. 1950.

465. ASARI, T. Geochemical distribution of Sr. IX. Sr contents in human bone from prehistoric to modern. Chem. Soc. Japan Jour. 71: 387-388. 1950.

466. BOGDASHEVA, A. V., and LEBEDEV, M. I. Calcium and phosphorus content of the pelvic bones of the horse. Leningrad. Vet. Inst. Sborn. Rabot 14: 192-194. 1954.

"Ca of the pelvic bones increases and P decreases with the age of the animal. This is not true of the metatarsals." (Chem. Abs. 50: 5121.)

467. FABRY, C., and DALLEMAGNE, M. J. Investigation of the structure of bone cells and pseudoapatite with the aid of radioisotopes. Experientia 11: 19. 1955.

"The main constituent of the bone salts with a Ca/P of 2.26 contains 10 Ca, 6 P plus 1/2 Ca. All Ca atoms have the same behavior with respect to Ca⁴⁵." (Chem. Abs. 49: 7613.)

468. FINEAN, J. B., and ENGSTROM, A. Apatite crystallites in bone. *Biochim. et Biophys. Acta* 23: 202. 1957.

"In discussing x-ray diffraction from bone, it is concluded that the wide-angle reflections and at least part of the low-angle scatter probably arise from apatite crystallites. As the low-angle scatter can be interpreted in terms of a single set of particles of uniform shape and size and similar orientation, it is suggested that the scatter arises mainly from the apatite crystallites, and that scatter from other particles must either be relatively weak or be of a form similar to that from the apatite. There is a close relation between the organization of the apatite crystallites and structure of collagen." (Chem. Abs. 51: 6808.)

469. FORBES, R. M., MITCHELL, H. H., and COOPER, A. R. Gross composition and mineral elements of adult human body. *Jour. Biol. Chem.* 223: 969-975. 1956.

"Two adult human bodies contained 27.93 and 4.32% ether extract respectively. Water constituted 70.11 and 72.9%, crude protein 23.81 and 20.62%, ash 6.81 and 6.01%, Ca 2.15 and 2.07%, P 1.13 and 1.11% and Mg 0.049 and 0.047% of the fat-free body wt. respectively. B and Co occurred in all tissues; highest concn. of B were found in the skeleton (0.6 to 0.9 p.p.m.) and of Co in the liver (0.126 and 0.064 p.p.m.). Be was found in liver and lungs and Sr in the skeleton." (Internatl. Abs. Biol. Sci. 7: 601.)

470. FOX, H. M., and RAMAGE, H. Spectrographic analysis of animal tissues. *Roy. Soc. London, Proc., Ser. B*, 108: 157-173. 1931.

Semiquantitative analysis of strontium in various animal tissues is presented.

471. FRANK, R. Improvements in techniques of preparation of bone and tooth for electron microscopy. *Soc. de Biol. [Paris] Compt. Rend.* 150: 994-996. 1956.

"Methods of fixation, decalcification, and shadowing the tissue sections are described." (Chem. Abs. 51: 2921.)

472. GROSHEV, M. K. A roentgen-osseometric method for the determination of mineral insufficiency in sheep. *Saratov. Zootekh. Vet. Inst. Trudy* 6: 152-159. 1956.

"The method is based on the quant. evaluation of the intensity of roentgenogram shadows of bones of different d.; this was used as an indicator of the mineral substances stored up in the bones. The set-up consisted of a roentgenological app. and photoosseometric camera. With the aid of the roentgen-osseometric combination it was possible to establish that the phosphorus-calcium salts (I) deposits differed with the different bones and with different parts of the same bone. Deposits of I of highest d. were observed in the supporting bones." (Chem. Abs. 51: 14874.)

473. HEVESY, G. Chloride content of the mineral constituents of the skeleton. *Acta Chem. Scand.* 11: 261-264. 1957.

"By adding Cl³⁶ to the diet of pregnant mice and to their offspring until they are outgrown uniformly labelled animals are obtained. Prior to administering non-labelled diet to the outgrown labelled mice the total activity of the body of one member of the litter is determined. All Cl³⁶ with the exception of that sequestered in the skeleton is then removed by keeping the mice for 6 months on non-radioactive diet. After that date the skeleton is found to contain 0.73% of the total activity which the sister mouse had prior to removal of the radioactive diet. From this figure the Cl content of the mouse the Cl sequestered in the skeleton of a 35 g. mouse is calc. to amount to 0.35 mg. While almost 90% of the bone Na is excess Na, the corresponding figure for Cl is about 10 only." (Internatl. Abs. Biol. Sci. 7: 3433.)

474. HIGGINSON, J. Studies on human bone from South African Bantu subjects. II. Histopathological changes in the ribs of South African Bantu infants. *Metabolism, Clin. and Expt.* 3: 392-399. 1954.

"Bone compn. was normal though in 25% of the cases histological evidence of rickets was seen. Findings suggest that osteoporosis in these children was more likely due to growth depression than to rickets. Growth depression was the most frequently seen lesion." (Author's abstract.)

475. HODGES, R. M., and others. The strontium content of human bones. *Jour. Biol. Chem.* 185: 519-524. 1950.

N. S. MacDonald, R. E. Nusbaum, R. Stearns, F. Ezmirlian, P. Spain, and C. McArthur, joint authors.

"Sr was detd. spectrographically on bone samples from 26 individuals varying in age from fetus to 75 yrs. and on 12 cadavers that had been preserved for 35 yrs. Fetal specimens averaged 0.016% Sr and other samples (including those from cadavers) 0.024%. The level in one hydrocephalic child was 0.054%. No differences were observed between parietal, vertebral, rib and femur bones." (Chem. Abs. 44: 10870.)

476. KULP, J. L., TUREKIAN, K., and BOYD, D. W. Strontium content of limestones and fossils. *Geol. Soc. Amer. Bul.* 63: 701-716. 1952.

"A rapid high-precision spectrographic technique is used to analyze a large no. of carbonate specimens for Sr to obtain significant geochem. and ecological data. The value of Sr/1000 Ca for all limestones is 0.71, and limestones are considerably lower in Sr than most fossils. The Sr content of fossils varies greatly, but on the av. it is about twice that of the surrounding matrix. No trends with age or fossil type were found; the primary factor which det. the Sr/Ca ratio in a shell or limestone is the Sr/Ca ratio of the water from which they formed, but other factors of importance include the salinity, ratio of aragonite to calcite in original shell, and subsequent recrystn. history. The Sr/1000 Ca values are given for a no. of limestones, dolomites, marbles, deep-sea oozes, and randomly selected fossils." (Chem. Abs. 46: 9034.)

477. LEES, H., and KUYPER, A. C. Organic acids of bone. *Jour. Biol. Chem.* 225: 641-649. 1957.

"Citric, malic, aconitic, succinic, and fumaric acids are present in compact bone in concn. of about 750, 5.5, 3, 2.5, and 0.2 mg./100 g. respectively. Citric, malic, aconitic and succinic acids are coprecipitated *in vitro* with bone salts from inorganic salt soln. The amounts of acids in the supernatant soln. required for coprecipitation of the amounts of acids present in bone are within the ranges of values reported for these acids for various tissues. When finely divided bone is incubated with C¹⁴ acetate, C¹⁴ is incorporated into the organic acids; the sp. activity of these acids varies inversely with the extent to which the acids are coprecipitated with bone salt." (Internatl. Abs. Biol. Sci. 8: 492.)

478. MARSH, H., and SWINGLE, K. F. Blood phosphorus, calcium, and vitamin A in range sheep. *Amer. Jour. Vet. Res.* 16: 418-424. 1955.

"The means of 517 detns. of levels of P, Ca, and vitamin A (I) in blood plasma of breeding ewes run on the range in the mountain area of south-central Montana were (per 100 ml.): P 4.3 mg. (± 0.9); Ca 9.2 (± 1.0); I 29 γ (± 7.3). The samples were taken in groups of 30 to 52 on 12 dates over a 4-year period, 11 of which were between October 9 and April 1; 1 set of 46 samples taken July 2 showed a higher P level, namely 5.4 mg./100 ml. Ewes fed a protein concentrate during the period of pregnancy did not show values significantly different from those for ewes on range with no supplement." (Chem. Abs. 49: 12671.)

479. MARSHALL, J. H., WHITE, V. K., and COHEN, J. Autoradiography of several cross sections of undecalcified bone. *Internatl. Jour. Appl. Radiation and Isotopes* 1: 191-193. 1956.

480. NORDIN, B. E. C. Solubility of powdered bone. Jour. Biol. Chem. 227: 551-564. 1957.

"Dried defatted, powd. calf bone in dialysis bags was equilibrated with inorg. solns. buffered at various pH levels and contg. various concns. of Ca and phosphate. All the expts. were performed in 0.05M solns. at 37°. The ratio of solid to fluid was 1:10 but observations were also made down to the ratio of 1:500. Whether equilibrium was approached from above or below, the final product of the Ca and phosphate concns. at pH 7.3-7.6 ranged from 0.24 to 0.74 micromoles/l., the mean being 0.44. This corresponds to an activity product to about 2.8×10^{-8} mole/l. The pK of the soly. product CaHPO_4 ranged from 6.2 to 6.7 and the pK of the soly. product $\text{Ca}_3(\text{PO}_4)_2$ from 24.7 to 26.7. When studies were performed from undersatn. over the pH range 6.2-7.8, the product $\text{Ca} \times \text{total phosphate}$ fell from 3.9 micromoles/l. at pH 6.2 to 0.19 at pH 7.8. In terms of secondary Ca phosphate, this pH effect could not be entirely accounted for by the dissoen. of H_3PO_4 , the pK ranging from 6.1 to 6.8. In terms of the tertiary salt, the pK of the soly. product was very steady at about 26.4 at pH 6.6-7.8. Observations from supersatn. at pH 6.2, 7.4, and 7.8 suggest that the range of pK for the secondary salt is slightly smaller than for tertiary salt in these expts. The results suggest that the tissue-fluid concns. of Ca and phosphate could represent an equil. with the bone salt if the pH on the surface of the bone crystal is about 6.6-6.8." (Chem. Abs. 51: 18049.)

481. ODUM, H. T. Notes on the strontium content of sea water, celestite radiolaria, and strontianite snail shells. Science 114: 211-213. 1951.

"Reported values for Sr in sea water range from 7.0 to 50 mg./l. O. made 235 detns. of the Sr/Ca ratio on 160 samples of Atlantic Ocean water (Long Island Sound, Middle Atlantic Ocean, Gulf Stream, etc.). Detns. were made by flame spectrophotometric methods on single and double oxalate pptns. The at. ratio Sr/Ca obtained is 0.00923, equiv. to 8.10 mg./l. Sr in salinity of 35 parts/mille, a value lower than given in some reference books. Thus, Sr is a conservative element in sea water varying with salinity. The total variation of Sr/Ca after removal of the analytical error is 8.4% for 95% of a group of analyses. Published Ca/Cl and Mg/Cl have a similar variation. Examn. of a plankton sample of radiolarian (probably *Acanthometra pellucidum*) by gravimetric, spectrophotometric, and x-ray powder pattern methods showed Ca and Sr 19.4, SO_4 , 36.9, R_2O_3 , 1.1, SiO_2 8.7, loss 33.9 av. % of ash. The diffraction pattern was identical with that of celestite. O. concludes that the chief crystal form present in this radiolarian is celestite. The physiology of deposition of celestite is obscure. In some standard books the radiolarian skeleton is described as consisting of SrCO_3 . Expts. with snails (*Physa*, species not given) raised in solns. of varying Sr concn. showed the shells could contain more than half strontianite (I); the Sr/Ca ratio was about 0.33 of that in the culture medium. X-ray diffraction studies of high Sr shells indicated the presence of small crystals of aragonite and I and not an amorphous intermediate of a substitution series. Similar high Sr concns. have been induced in other organisms. 24 references." (Chem. Abs. 45: 8668.)

482. PRITCHARD, J. J. Cytology and histochemistry of bone and cartilage formation in the rat. Jour. Anat. 86: 259-277. 1952.

"A cytological and histochem. investigation of ossification was made on fetal rats with the object of defining the changes which occur during the differentiation of osteoblasts and chondroblasts from the mesenchymal precursors, and of relating these changes to the stages in the deposition of intracellular arteries. Particular attention was paid to changes in glycogen storage, alk. phosphatase activity, cytoplasmic basophilia, intensity of the Feulgen nuclear reaction, no. of mitochondria and size of the Golgi elements. The findings are discussed in the light of current theories of biochem. mechanisms involved in bone formation. It is suggested that the osteoblast contributes to the deposition of the matrix by secreting alk. phosphatase, a collagen

precursor, hexose phosphates and mucopolysaccharides." (Chem. Abs. 48: 10163.)

483. RAY, R. D., and WARD, A. A., JR. Basic calcium phosphate in bone replacement. Surg. Forum, Amer. Col. Surg. 37th Cong. Proc. 1951: 429-434. 1951.

"Synthetic hydroxyapatite crystals were used to repair exptl. surgical defects in the long bones of 3 dogs, trephine holes (I) in the iliac wings of 12 dogs, and I in the skulls of 16 cats and 6 monkeys. The crystals were incorporated in the new bone and were replaced in ossification after acting as a matrix for bone formation. As compared to untreated control defects, the crystals promoted healing, although it was not as rapid as when the defects were filled with fresh autogenous cancellous bone chips. 23 references." (Chem. Abs. 50: 12252.)

484. SLESAREVA, E. N. Strength of cattle bones in relation to their structure and chemical composition. Dok. Moskov. Sel'skokhoz. Akad. im. K. A. Timiryazeva 25: 293-300. 1956-57.

"Cattle were fed a Ca-deficient diet. The bone Ca content was reduced and P and Mg increased. Rations contg. a high percentage of concd. feeds tended to increase the Mg content of the bones and thereby to weaken their structure." (Chem. Abs. 51: 18204.)

485. SOWDEN, E. M., and STITCH, S. R. Trace elements in human tissue. II. Estimation of the concentrations of stable strontium and barium in human bones. Biochem. Jour. 67: 104-109. 1957.

"A method based on the technique of Harrison and Raymond (C.A. 49, 12571 g) has been used for the detn. of Sr and Ba in human bone by radioactivation analysis. Results of analyses of 35 bone samples, from normal persons of both sexes and different ages, are given. The concns. of Ba and Sr were found to be of the order of 7 and 100 γ /g. of ashed tissue, resp. No relation between sex or disease of individuals age group 0-13 yrs. was significantly lower than in the group 19-74 yrs. No significant difference was found in the concns. of Sr and Ba in the various bones of those individuals examd. The results obtained in this survey are discussed and compared with those of other workers." (Chem. Abs. 51: 18184.)

486. SPECKMAN, T. W., and NORRIS, W. P. Bone crystallites as observed by use of the electron microscope. Science 126: 753. 1957.

"The inorganic crystallites (apatite) in normal, mature, cortical bone from humans and dogs are rod- or needle-shaped structures, not hexagonal platelets, and are 50 A. thick and ordinarily 600-700 A. long. No fine structure is observed." (Chem. Abs. 52: 2204.)

487. TIPTON, I. H., and others. Progress report: Spectrographic analysis of tissues for trace elements July 1, 1955 through Dec. 31, 1955. U.S. Atomic Energy Comm. ORNL-56-3-60, 47 p. 1956.

M. J. Cook, R. L. Steiner, W. D. Foland, D. K. Bowman, and K. K. McDaniel, joint authors.

"Normal human tissues were analyzed spectrographically for the presence of certain low-concentration elements. Tabulated data are arranged by elements and by tissues." (Nuclear Sci. Abs. 10: 3173.)

488. TIPTON, I. H., and others. Spectrographic analysis of normal human tissue from Baltimore, Maryland. U.S. Atomic Energy Comm. ORNL-57-11-33, 59 p. 1957.

M. J. Cook, R. L. Steiner, J. M. Foland, K. K. McDaniel, and S. D. Fentress, joint authors.

"Normal human tissues were analyzed spectrographically for the presence of certain low-concentration elements. Tabulated data are arranged by elements and by tissues." (Nuclear Sci. Abs. 12: 2234.)

489. TIPTON, I. H., and others. Spectrographic analysis of normal human tissue from Dallas, Texas. U.S. Atomic Energy Comm. ORNL-57-2-3, 51 p. 1957.

M. J. Cook, R. L. Steiner, J. M. Foland, K. K. McDaniel, and S. D. Fentress, joint authors.

"Normal human tissues were analyzed spectrographically for the presence of certain low-concentration elements. Tabulated data are arranged by elements and by tissues." (Nuclear Sci. Abs. 11: 6595.)

490. TIPTON, I. H., and others. Spectrographic analysis of normal human tissue from Miami, Florida. U.S. Atomic Energy Comm. ORNL-57-2-4, 61 p. 1957.

M. J. Cook, R. L. Steiner, J. M. Foland, K. K. McDaniel, and S. D. Fentress, joint authors.

"Normal human tissues were analyzed spectrographically for the presence of certain low-concentration elements. Tabulated data are arranged by elements and by tissues." (Nuclear Sci. Abs. 11: 7944.)

491. TRUEMAN, E. R. Occurrence of strontium in molluscan shells. *Nature* 153: 142. 1944.

"Small traces of Sr are commonly found in shells consisting of aragonite; however, its occurrence is not universal, and though it may be a factor leading to the formation of aragonite, other factors must also be involved. No evidence of Sr was obtained in calcite shells examd." (Chem. Abs. 38: 2398.)

492. TUREKIAN, K., and KULP, J. L. Strontium content of human bones. *Science* 124: 405-407. 1956.

"Marked regional differences in the Sr content of human bones were observed as a result of the analyses of 277 human bones from a world-wide sampling. The % Sr/% Ca $\times 10^3$ ratio was detd. on bones ashed at 800° for 12-24 hrs. This ratio was not affected by bone type, age or sex. Bones from Brazil and Liberia had high av. ratios, Denmark, Italy, and Japan, intermediate av. ratios, and Cologne, Switzerland, and Bonn low av. ratios (1.33, 1.25, 0.89, 0.71, 0.70, 0.36, 0.35, and 0.35 resp.). Analyses of bones of 9 other regions were also reported." (Chem. Abs. 50: 15801.)

493. VAN DER WAL, P. Structure of the compact bone of the metatarsus in relation to calcium and phosphorus metabolism in the ruminant. *Wageningen Landbouwhoogesck. Lab. v. Fysiol. Meded.* 56: 95. 1956.

"The first 2 sections describe the structure and growth of bone with reference to the effects of mechanical stress, diet, rate of growth and age, pregnancy, lactation and tuberculosis; the third deals with published descriptions of the structure and growth of the metatarsus in cattle. The material investigated was metatarsal bones collected from slaughterhouses; the origin and clinical histories of the animals from which they came were checked as far as possible. Data for 15 are shown in the first table and the structure and changes of bone with age, as deduced from the histology of these bones, are set out in detail. The number of resorption cavities in the bone and the amount of secondary disposition of bone are taken as indicating removal and deposition of Ca and P. In 64 bulls and 327 cows from which metatarsal bones were procured in the same way, changes with age, season in which an animal was slaughtered, reproductive history and stage of pregnancy or lactation are described. The number of resorption cavities increases to 2 years of age, decreases to the tenth year and increases again. Bone is laid down during the second and third trimesters of pregnancy and removed during the first 3 months of lactation. There was no evidence of milk yield. Stall feeding had an unfavourable effect and so had tuberculosis. Variations at all ages in all circumstances investigated were wide." (Nutr. Abs. and Rev. 27: 3775.)

494. VAN NIEUWENBURG, C. J., and DEWALD, R. H. The geochemical frequency of strontium. *Rec. des Trav. Chim. des Pays-Bas.* 54: 633-638. 1935.

495. VINCENT, J. Research on the constitution of compact bone tissue. *Arch. de Biol.* 65: 531-569. 1954.

"In canine and human compact bone, microradiography shows that the outer layers of each new Haversian system

are heavily calcified, while there is less Ca in the newer inner layers. The organic substance of the peripheral zone is metachromatic, becoming nonbasophilic below pH 5.6. The central zone is periodic-acid-Schiff positive. It is made metachromatic by H_2SO_4 or CrO_3 . Below pH 4 it is not basophilic. S^{35} concentrates in the osteogenic zones. It is proposed that sulfomucopolysaccharides, acid at the periphery and neutral in the center of the osteone, operate in the retention of Ca." (Biol. Abs. 29: 21438.)

496. VIRTAMA, P. Quantitative determination of bone minerals from roentgenograms. *Experientia* 13: 236-237. 1957.

497. WADHWANI, T. K. Constitution of bone salt and tricalcium phosphate II. *Indian Chem. Soc. Jour.* 31: 365-372. 1954.

"By equilibrating $Ca_3(PO_4)_2$ or bone salt repeatedly with NaF soln. the adsorbed PO_4 and OH ions are replaced by F ions. These in turn can be replaced by OH ions after equilibration with NaOH. The PO_4 ions can also be taken up by the salts. All such uptake is in accord with the adsorption isotherms. The amt. of replaced ions in each case is too great to be due to a labile surface form of bone salt. Thus, bone salt cannot be considered to be composed of a labile and a nonlabile fraction." (Chem. Abs. 49: 7019.)

498. WATERHOUSE, D. F. Occurrence of barium and strontium in insects. *Austral. Jour. Sci. Res. B4:* 144-162. 1951.

"Both Ba and Sr were detected in the tissues of many insects by a histochem. test using Na rhodizonate, and also by spectrochem. analysis. The specificity of the histochem. test was examd. Ca did not appear to interfere under neutral conditions. Treatment with chromate inhibited the reaction with Ba, but not with Sr. The distribution of Ba and Sr was characteristic for each species; both occurred most frequently in the malpighian tubules, less often in the midgut and reproductive organs, and very occasionally in the hindgut and fat body; but almost always as constituents of granules." (Chem. Abs. 45: 10412.)

METABOLISM AND DEPOSITION OF STRONTIUM AND CALCIUM IN THE TEETH

499. BELANGER, L. F. The mineralization of rat enamel in the light of Ca^{45} autoradiography and microincineration. *Jour. Dent. Res.* 36: 595-601. 1957.

"In a descriptive article the histological changes are discussed as seen by autoradiography and microincineration of the teeth of three 4-day old hamsters and of five 6-day old and two 10-day old rats after single doses of Ca^{45} given subcutaneously, 3 γ c. per g. bodyweight. Entry into and transit in dentine were similar to those previously reported in pigs (Abst. 880, Vol. 25), in enamel there was generally a diffuse band extending the whole length of the substance and with intensity lower than in dentine. In the rat's incisor mineralization was regular but in the molar less so. Massive mineralization occurred when secretion of organic matrix ceased and was followed by progressive and general mineralization." (Nutr. Abs. and Rev. 28: 850.)

500. DAGAEVA, L. N. Significance of saliva in mineral metabolism of tooth enamel. *Stomatologiya* 5: 17-21. 1955.

"In the dog the enamel of depulped teeth continues to include orally or parenterally administered Ca^{45} at a time when the dentine of the crown and root display only traces of radio-activity in comparison with a healthy control tooth. When teeth were protected from saliva by means of metal caps before the administration of Ca^{45} , the enamel took up practically none of the radio-calcium, although it was found in the dentine. It is held that the saliva is the most important source of supply of Ca to the enamel." (Internatl. Abs. Biol. Sci. 7: 174.)

501. ERICSSON, Y. The uptake of radioactive calcium and phosphorus by intact and carious enamel surfaces. *Acta Odontol. Scand.* 11: 167-178. 1954.

"Standard sized areas of freshly extracted teeth were exposed for from 16 to 28 hrs. to solns. of Ca^{45} and P^{32} . After washing in water for 5 min. radioactive measurements were obtained directly from the exposed surface. In addition P^{32} assay was obtained from a constant wt. of the exposed enamel dissolved in acid. A corresponding Ca^{45} assay was done on precipitated Ca oxalate. Carious enamel picked up greater amts. of the isotopes than intact enamel." (*Biol. Abs.* 29: 997.)

502. HARTLES, R. L., and LAWTON, F. E. Experimental dental caries in the albino rat. *Brit. Jour. Nutr.* 11: 18-22. 1957.

"Rats on a 67% starch diet grew at a slower rate but had only $\frac{1}{3}$ the no. of carious teeth as those on a 67% sucrose diet." (*Chem. Abs.* 52: 3057.)

503. ITO, Y., and others. Physiological chemistry of the hard tissues. I. Dynamics of labeled calcium uptake by the incisors of the rat. *Jour. Biochem.* 43: 701-710. 1956.

S. Tsurufuji, Y. Hiramatsu, and M. Chiba, joint authors. "Male albino rats (body wt. approx. 190 g.) were given 4 microcuries $\text{Ca}^{45}\text{Cl}_2$ intravenously, followed by 10 injections of each 1 microcurie dose at 30-min. intervals. Radioactivity of Ca^{45} in serum was approx. const. from 30 min. after the first injection; total Ca^{45} uptake from serum into lower incisors (I) was increased rectilinearly with time. The total Ca uptake was calcd. as 44 $\gamma/\text{hr.}$ (av. of 19 rats). With the use of 20 rats (40 pieces of I) the growth rate was estd. to be $0.0170 \pm 0.0006 \text{ mm./hr.}$ by *in vivo* dyeing with Na alizarin sulfonate. The rate of Ca deposition per mm. of the growing apical part of I was calcd. as $25.8 \pm 1.1 \gamma/\text{hr.}$ (60% of total Ca uptake) and the physiochem. Ca exchange from serum to I as av. 18.2 $\gamma/\text{hr.}$ (40% of the total)." (*Chem. Abs.* 51: 2143.)

504. ITO, Y., TSURUFUJI, S., and HIRAMATSU, Y. Physiological chemistry of the hard tissues. III. Metabolism and distribution of glycerophosphate- P^{32} and its incorporation into rat incisor. *Jour. Biochem.* 44: 769-777. 1957.

"A mixture of x- and B-glycerophosphate labeled with P^{32} with high specific activity was synthesized and administered intravenously to experimental animals in order to investigate their metabolism, distribution, and incorporation into calcified tissues in comparison with inorganic phosphate- P^{32} . Glycerophosphate injected intravenously was rapidly hydrolyzed and the resulting inorganic phosphate was liberated into the blood stream and excreted into the urine. As specific activity of inorganic phosphate in the urine was higher than that of the serum, it was found that phosphatase in the kidneys releases inorganic phosphate from phosphate ester into the urine. Determinations of radioactive phosphorus remaining in the serum indicates that inorganic phosphate is more diffusible through cell membranes than glycerophosphate. Actively growing incisor teeth of a rat and dental pulps of the incisor took up more radiophosphorus from glycerophosphate- P^{32} than inorganic phosphate, contrary to the results for other tissues examined. This indicates that phosphorus in glycerophosphate has a specific affinity to actively calcifying tissues and suggests an important role of ester phosphate in the mechanism of calcification." (Author's summary.)

505. KINERSLEY, T. Beta-track autoradiographic study of teeth with calcium-45. *Yale Jour. Biol. and Med.* 27: 114-118. 1954.

"Sections, 50-75 μ thick of extd. human teeth, incubated in $\text{Ca}^{45}\text{Cl}_2$ (I) solns. were exposed to photographic plates for beta-track counting estn. of I uptake. The I uptake of carious enamel (II) is greater than that of normal. Dentine (III) I uptake is greater than that of II. Carious III takes up more I than does normal." (*Chem. Abs.* 49: 11827.)

506. KUMAMOTO, Y., and LEBLOND, C. P. Radioautographic study of mineralization of growing teeth with labelled calcium. *Jour. Dent. Res.* 35: 147-156. 1956.

"Newborn and 3 day old rats were given a single injection of 1 mc./gm. body wt. of labelled CaCl_2 . The animals were sacrificed at intervals up to 9 days. The labelled salts were deposited in incremental layers of 18 μ /diem adjacent to the predentine. As growth continued the maximum amount of labelled salts became further from the predentine whilst retaining its relationship to the outer surface of the dentine. Autoradiographic images over developing enamel were less intense, but there was an increasing gradient of reaction oriented incisally and toward the dentino-enamel junction." (*Internatl. Abs. Biol. Sci.* 4: 5197.)

507. LISENKO, N. V. Phosphorus exchange in dental tissues in caries according to data by isotopic method. *Stomatologiya* 2: 3-9. 1956.

"Mineral exchange was studied in intact and carious teeth in people, with the aid of P^{32} , administered perorally in the form of Na_2HPO_4 soln. The largest amount of occluded P^{32} in enamel of intact teeth is concn. in the surface layers. Deep-seated layers of enamel either do not occlude P^{32} at all or only in very small amounts. The amount of occluded P^{32} in the dentine of the root, for example, is equal to the amount of occluded P^{32} in dentine of the crown. The greater amount of total P^{32} introduced is concn. in the cementum of the crown. The character of the P^{32} occluded in tissue of carious teeth is markedly different from the P^{32} occluded in intact teeth. Percentage P^{32} occluded in the surface layer of the enamel, in dentine of teeth is always higher for carious teeth. Enamel in chalky patches is capable of occluding a larger amount of P^{32} than in sound parts. Softened dentine of the crown occludes very much more P^{32} than dentine of the tooth which is morphologically the same, and is many times greater than for dentine of the intact tooth." (*Internatl. Abs. Biol. Sci.* 7: 3210.)

508. MYERS, H. M. Location of radiocalcium in the mandibular incisor and adjacent structure of the rat. *Jour. Dent. Res.* 34: 217-224. 1955.

"Female rats (age 9 weeks) were each given 5 microcuries of Ca^{45} of CaCl_2 by intravenous injection. Ca^{45} was present 1 hr. later in 2 distinct areas, the labial enamel of the incisor and the dentine; between 2 and 8 days fusion occurred of the Ca^{45} area about the pulp and that of the labial portion of the tooth. Ca^{45} occurred within or immediately adjacent to both radiolucent and radiopaque portions of the developing enamel and was present in the teeth and bone 1 week after its blood concn. was no longer favorable to exchange reactions with these tissues. 33 references." (*Chem. Abs.* 49: 10467.)

509. PIERUCCINI, R., and ZOTTI, R. Biological function of strontium and manganese in teeth. *Atti della Soc. Toscana di Sci. Nat. (Pisa) Mem. (Ser. A)* 56: 119-126. 1949.

"Spectrochem. analysis of teeth ash showed Sr, Na, Cu, Fe, Al, Si, B, Mn, Pb, and Li as minor constituents. Ni and Co were absent. Fe, Al, Si, and Cu are geochemically very diffuse and Na and B are always present in organisms. Sr was higher in sound than in carious and higher in children's (even carious) than in adult's teeth. Sr decreased with the age. Mn was higher in carious than in sound and higher (slightly) in adults' than in children's teeth. Carious children's teeth contained more Mn than adults'." (*Chem. Abs.* 45: 2087.)

510. PROKHONCHUKOV, A. A. Mineral metabolism in bones and teeth investigated by labelled atoms in normal, and in functional depression of cerebral cortex. *Moskov. Med. Stomatol. Inst. Nauch. Raboty* 1: 19-32. 1955.

" P^{32} was administered subcut. to mice; after 3 to 48 hr. they were killed and the radioactivity and total P were determined in the ash of the femur and of the teeth. The

incorporation of P^{32} into the teeth of mice made "neurotic" by Petrova's method was less than in the controls, particularly in mice of an excitable type. The same regularity was seen in the bones, but less clearly. The content of total P in teeth and bones of the neurotic mice was increased, particularly in the excitable animals. In the normals the max. incorporation of P^{32} occurred after 10 hr.; in the neurotics after 20-48 hr. The effect on mineral metabolism of functional weakening of the cerebral cortex is related to enhanced functioning of subcortical centres." (Internatl. Abs. Biol. Sci. 7: 3201.)

511. SOMOGYI, J. C., and MUHLEMANN, H. R. Calcium and phosphorus metabolism of the intact enamel of human teeth under different experimental conditions. Internatl. Ztschr. f. Vitaminforsch 27: 72-84. 1956.

"The influence of NaF was itself influenced by pH. Previous treatment with NaF at pH 2.9 decreased the soly. at pH 4.0 by approx. 50%; previous treatment at pH 7.0 caused soly. at pH 4.0 to be 25% less than in controls. In equimol. concns. retardation was better by approx. 17% with SnF_2 than with NaF. The min. F concn. with a retardive effect was 0.017% NaF. When the period of pretreatment was 0.5 min. or less, inhibition did not occur. 26 references." (Chem. Abs. 51: 9916.)

512. TORRES, R. N. Action of zinc and strontium salts on the dento-paradental unit of laboratory mice. Córdoba Univ. Nac. Facult. Cien. Méd. Rev. 11: 253-269. 1953.

"Four groups of white mice, 25 to 28 days old, weighing from 4 g. to 5 g. per group were placed on a diet consisting of milk-soaked bread, bran, oats and corn meal. One group received 1 ml. of 12% Sr lactate (I) in their diet for 4 days; the dose was then increased to 2 ml. daily for the next 22 days. A second group was given 0.5 ml. of 12% $ZnSO_4$ (II) during the first 2 days; this was increased to 0.75 ml. on the 3rd day and to 1.0 ml. on the 6th day and for 20 days thereafter. A 3rd group received 1 ml. of 12% II for 2 days, 1.5 ml. the next 2 days, 2.0 ml. on the 5th day. All the mice in this group died 2 hours later. The 4th group served as controls. After 30 days, the mice were sacrificed and the heads removed. The materials were fixed in 10% alk. formalin; decalcified with 5% HNO_3 ; imbedded in paraffin, stained with hematoxylineosin (Van Gieson-Mallory) and impregnated with $AgNO_3$. The effects of I and II were essentially the same. Histological sections of the incisors showed distortion of Owens' lines, hyperplasia of dentine, hyperemic pulp, and edema of interfascicular cellular spaces of the periodontal membrane. The adamantine epithelium was hyperplastic and ameloblastic cells appeared vacuolized." (Chem. Abs. 48: 1558.)

513. WAINWRIGHT, W. W. Dental uses of radioisotopes. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (10): 440-452. 1956.

514. WEINMANN, J. P. Effect of strontium on the incisor of the rat. I. Injections of small doses of strontium chloride as a means of measuring the rate of incremental dentine apposition. Jour. Dent. Res. 21: 497-504. 1942.

" $SrCl_2$ was administered to 23 rats (age 23-96 days) subcutaneously in single or multiple doses of 70-680 mg. per kg. of body wt. Even the 70-mg. dose produced, in the dentine then growing and calcifying, sharp incremental lines which could be used to measure the rate of dentine apposition; the enamel showed a less sensitive reaction to Sr. This administration of Sr did not retard the normal rate of increase in body wt. Measurement of the rate of dentine apposition suggested that it was faster after $SrCl_2$ than after Alizarin Red S. 23 references." (Chem. Abs. 37: 2462.)

515. WOHINZ, R. The effect of small doses of fluorine, phosphorus, strontium and pituitary body on the chemical composition of the teeth of young dogs. Deut. Zahnärztliche Wchnschr. 41: 684-687. 1938-39.

"Feeding expts. reported were continued for 1 year. Daily doses of 15 g. pituitary body, 0.00001 g. red P,

0.01 g. CaF_2 or 0.05 g. $SrCl_2$ were administered. The feeding of P and F produced a decrease in the H_2O content of the teeth. P increased the content of the teeth in P and in org. matter. F reduced the P content and increased the F content. Feeding of P increased the Mg content, while when F was fed Mg was entirely lacking in the teeth. The F was administered obviously in doses less than the toxic dose; it produced no external changes in the teeth. Sr was scarcely deposited in the teeth at all. The behavior of the liver under the influence of these various diets is described." (Chem. Abs. 34: 7009.)

DEPOSITION OF STRONTIUM AND CALCIUM IN THE EGG AND METABOLISM IN THE EGG-LAYING PROCESS

516. BANKS, E. M., and ODUM, H. T. Strontium deposition in eggshells. Tex. Jour. Sci. 9: 215-218. 1957.

"Two Rhode Island Red pullets were fed a com. mash contg. 2.24% Ca. The $SrCO_3$ content of the eggshells was 2-3%. The $SrCO_3$ content rose to 25% after 3 days on exptl. feed of high Sr/Ca ratio consisting of 3 lb. yellow corn meal (0.04% Ca), 1 lb. soybean meal (0.28% Ca), and 171.6 g. powd. $SrCO_3$. Shells were ashed at 600°. Portions (0.1 g.) were dissolved in 10 ml. of 20% HCl and analyzed for Sr with the Beckman flame spectrophotometer. The Sr/Ca ratio in the shell was lower than the food ratio. B. and O. suggest a simple means of obtaining information on the distribution of radioactive Sr over wide food producing areas from assay of chicken eggshells." (Chem. Abs. 51: 14925.)

517. COMAR, C. L., and DRIGGERS, J. C. Secretion of radioactive calcium in the hen's egg. Science 109: 282. 1949.

"Approx. 1 mg. of Ca^{45} (I) with an activity of 15 μc . was administered into the lower esophagus of the fasted bird. Each egg laid for a period of 20 days after dosage was analyzed for total Ca and I uptake in the yolk, white, and shell. In an egg laid 15 min. after dosage, the shell contained a detectable amt. of I representing 0.07% of the dose. The next egg laid at 24 hrs. contained 30-35% of the dosage of I in the shell, the values falling sharply and leveling off at about 0.5% in succeeding eggs. No I was detected in the yolk and white of the 15 min. egg. In the 24-hr. egg the white contained about 70 times as much I as did the yolk. The situation was reversed in the 48-hr. egg and all those thereafter. The total percentage accumulations in the yolks, whites, and shells of 14 eggs collected after dosage were 0.7, 0.2, and 40, resp. Bone analysis showed considerable skeletal storage of I; the left pubis contained about 1 γ of I per g. of bone. About 0.005% of the dose was found in the blood." (Chem. Abs. 43: 6715.)

518. DREA, W. F. Spectrum analysis of hen eggs and chick tissues. Jour. Nutr. 10: 351-355. 1935.

"A number of elements pass from the feed and/or water into the hen's blood, from there into the egg, and finally into all the chick's tissues and blood. These are aluminum, barium, calcium, copper, iron, magnesium, phosphorus, potassium, rubidium (?), silicon, sodium, strontium, titanium, and vanadium. Manganese and zinc were each absent from one organ and the chick's blood. Of the 'trace' elements, aluminum, barium, copper, silicon, strontium, titanium, and zinc were quite uniformly distributed among the tissues." (Author's summary.)

519. JACOBS, T., and GOVAERTS, J. L'utilisation du radiocalcium pour l'étude du métabolisme du calcium chez l'embryon de la poule et le poussin. [Use of radiocalcium to study calcium metabolism in the chick embryo and in the chick.] Arch. Internatl. de Physiol. 59: 333-340. 1951.

" Ca^{45} was injected into fresh eggs which were then incubated 7-19 days. Radioactivity detns. were carried

out at intervals on the embryo, vitellin plus albumin, and the amniotic fluid. The sp. activity of the embryo fell from 3.6 to 0.8 during this time, but that of the albumin and vitellin dropped only from 2.2 to 1.0. The amniotic fluid remained const. at about 2.5. In chicks only 3.7 of the Ca^{45} injected into the egg was excreted in the droppings during 25 days after hatching. The viscera contained no activity, but the bones were uniformly labelled and accounted for 69–86% of the administered dose.” (Chem. Abs. 47: 6508.)

520. JOHNSTON, P. M., and COMAR, C. L. Distribution and contribution of calcium from the albumin, yolk and shell to the developing chick embryo. *Amer. Jour. Physiol.* 183: 365–370. 1955.

“Data are presented on the daily Ca contents of the albumin, yolk, and embryo from 3 to 21 days after the start of incubation; samples were also taken from the chick for 8 days thereafter. The albumin was labeled at zero days with Ca^{45} , and radioassays were made of the various components. The embryonic ash increased logarithmically between 3 and 9 days and between 9 and 19 days. The Ca of the embryo increased logarithmically between 3 and 9 days, between 9 and 15 days, and between 15 and 21 days. The embryonic Ca^{45} derived from the albumin ranged from 0.00076% of the dose at 3 days to 82% at 20 days. Specific-activity values indicated that up to about 10 days most of the embryonic Ca was derived from the yolk. After 10 days, the shell started to contribute Ca to the embryo. In general, the movement of Ca among the various egg components was correlated with accepted morphological and physiol. concepts.” (Chem. Abs. 50: 6634.)

521. JOWSEY, J. R., and others. Uptake of calcium by the laying hen, and subsequent transfer from egg to chick. *Poultry Sci.* 35: 1234–1238. 1956.

M. R. Berlie, J. W. T. Spinks, and J. B. O’Neil, joint authors.

“Approx. 35% of the Ca in the shell of an egg came from the gut during period of shell formation when daily intake of calcium was 9.5 g. of CaCO_3 . About 60% of ingested Ca was excreted during a 24-hr. balance period. The developing embryo withdraws approx. 5% of shell Ca during incubation.” (Chem. Abs. 51: 14916.)

522. NOZAKI, H., HORII, S., and TAKEI, Y. Utilization of shell Ca by chick embryo. *Natl. Inst. Agr. Sci. Bul. [Japan]*, Ser. G: 89–95. 1954.

The tracing of Ca^{45} administered to the laying hen revealed that over 99 percent of the total amount distributed in the eggs laid within 2 days was found in the shell (Nozaki, 1953). These experiments were made to clarify further the utilization of shell Ca by the chick embryo for its development. The first and second eggs laid by the six hens within 3 days after oral administration of Ca^{45} were incubated, and the change in Ca^{45} amount distributed in different parts of the egg was measured on the 5th, 12th, and 18th days of incubation and at hatching. Various kinds of calculations were conducted on the transfer of Ca based on the specific activities in the sectioned parts of the eggs. Comparison of these results with the results of the authors’ previous experiment, where Ca^{45} was injected into the yolk and white, disclosed the following facts: (1) The egg shell loses about 150 mg. of Ca during incubation, which is about three times the amount in the yolk and white. (2) The Ca utilized for the development of the embryo in the early stage of growth was mainly derived from the yolk and a little from the white. (3) Ca in amniotic and allantoic fluids during the middle stage of incubation was mostly derived from the yolk. (4) During the last half of incubation, more than half of the total amount of Ca collected by the embryo was from the shell, about one-fourth from the yolk, and the rest from the white and other parts. (5) During the last stage the yolk was a main source of Ca supply to the embryo, whereas the yolk itself was receiving a considerable amount of Ca from the shell. The amount of Ca flowing into the

yolk during incubation was approximately the amount contained in the yolk at egg laying.

523. POLIN, D., and STURKIE, P. D. The influence of the parathyroids on blood calcium levels and shell deposition in laying hens. *Endocrinology* 60: 778–784. 1957.

“Parathyroidectomy in laying hens markedly decreased diffusible and non-diffusible plasma Ca, with subsequent expulsion of uterine eggs. If expulsion did not occur, the hen died in hypocalcemia. The presence of eggs in the uterus is a stimulus for shell deposition and the loss of such eggs from the parathyroidectomized hen increases the chance for survival.” (Chem. Abs. 51: 15752.)

524. SALEM, H., and REDA, H. Calcium and phosphorus metabolism and egg-shell formation in Egyptian birds. *Poultry Sci.* 34: 197–205. 1955.

“High-Ca diets (2.2 to 2.3%) resulted in lower retention of Ca and P. Blood Ca was increased during egg-shell formation and following the administration of diethylstilbesterol.” (Chem. Abs. 49: 12629.)

525. SANCHEZ, F. S., MOSQUERA, G. V., and BERTRAN, E. C. Influence of chelating agents on the formation of egg shells. Action of ethylenediaminetetraacetic acid on permeability and calcium content. *Madrid Inst. de Invest. Vet. An.* 6: 115–126. 1954.

“The chem. properties and biol. effects of ethylenediaminetetraacetic acid (I) and its salts are reviewed and interpreted. In 2 groups of 6 hens (8-month Leghorns), 3 were given 10 ml. 2.5% Na-I by mouth, and 3 given 1 ml. intramuscularly, for 30 days. The I produced no changes in the rhythm of setting or egg production. The eggs from the I-treated and the control (untreated) hens lost wt. on storage for 14 days at 37° at essentially the same rate, indicating that I did not modify the porosity of the egg-shells. However, the shells of eggs from I-treated hens were roughened about 20–25 days from the beginning of the treatments. There was also a decrease in the Ca content of the shells (quant. data not given), in the latter days of the expts. with some variations between the different hens.” (Chem. Abs. 49: 1394.)

526. SASAKI, R. Studies on the metabolism of calcium and phosphorus in the laying hen. *Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc.* 1955 (12): 275–277. 1956.

527. SCARDAVI, A. Origin of skeletal calcium in chicken. *Bol. Chim. Farm. [Milano]* 95: 423–426. 1956.

“The Ca content of the chick embryo at the end of development is 6 times as large as at the beginning of development. The Ca of the shell is assimilated. The mechanism is discussed.” (Chem. Abs. 51: 3766.)

528. SHIRLEY, R. L., and others. Effects of massive doses of P^{32} and Ca^{45} on laying hens. *Poultry Sci.* 33: 612–615. 1954.

J. C. Driggers, J. P. Feaster, J. T. McCall, and G. K. Davis, joint authors.

“Hens that survived single doses of 6.0 mc. of P^{32} succumbed upon receiving 8.0 mc., 11 to 12 days after dosage. Hens receiving a total of 34.5 mc. of Ca^{45} over 10 months with single doses as high as 12 mc. showed no adverse effect during a two-year period following dosage. The Ca^{45} had no observed effect on any of the blood cells and the P^{32} had no effect on the total red and white cell counts. For 3 weeks previous to their death hens receiving high levels of P^{32} had no monocytes or neutrophils in their blood. The hen appears to be very resistant to radiation damage.” (Chem. Abs. 48: 10150.)

529. SHIRLEY, R. L., and others. Excretion and retention of P^{32} and Ca^{45} by laying hens. *Poultry Sci.* 30: 730–734. 1951.

J. C. Driggers, J. T. McCall, G. K. Davis, and N. R. Mehrhoff, joint authors.

Orally administered radioactive Ca^{45} and P^{32} in individual and concurrent doses were found in the excrement for 45 and 65 days after dosage, resp. A total of 50.4% of the Ca^{45} dose and 52.8% of the P^{32} dose was excreted. Approx. 90% of the excretion occurred in the first 4 days after dosage. At approx. 130 days after dosage the hens contained between 0.01 and 0.05% Ca^{45} and P^{32} /g. of bone tissue, except for the pubis which contained no P^{32} ." (Chem. Abs. 46: 6221.)

530. SHIRLEY, R. L., and others. The rate of deposition and turnover of P^{32} and Ca^{45} in the tissues of the laying hen. *Poultry Sci.* 33: 932-936. 1954.

J. C. Driggers, J. T. McCall, M. Nienberg, and G. K. Davis, joint authors.

The rate of deposition and turnover of P^{32} and Ca^{45} between 0.25 hour and 21 days indicates that these two elements undergo an especially rapid metabolism in the laying hen. Turnover rates in the soft tissues emphasize the higher level at which P equilibrium is established between bone, blood, and soft tissue.

531. SPINKS, J. W. T., BERLIE, M. R., and O'NEIL, J. B. Determination of the fate of calcium in the laying hen by means of radiocalcium (Ca^{45}). *Science* 110: 332-333. 1949.

"A hen was fed 1.71 g. CaCO_3 with Ca^{45} activity of 2×10^6 counts/min. The Ca in the eggs and droppings was sepd. as CaC_2O_4 and activity detd. Max. recovery (29%) occurred in the shell of the second egg and decreased rapidly in later eggs. This agrees with other information that the shell is laid down in about 20 hrs. of oviposition. The shell takes about 11%, the white about 9%, and the yolk about 3.5% of total Ca fed, in good agreement with P uptake. While the uptake of Ca^{45} drops sharply at the end of 48 hrs. in both the shell and white, the drop in yolk proceeds more slowly (6 days). Another bird was given a daily feed contg. 1.7 g. active CaCO_3 for 10 consecutive days. The uptake of radioisomer became const. in about 8 days. This is in contrast to P^{32} which takes 15 days." (Chem. Abs. 44: 1584.)

532. TAYLOR, T. G., and MOORE, J. H. Skeletal depletion in hens laying on a low-calcium diet. *Brit. Jour. Nutr.* 8: 112-124. 1954.

"Eight pullets were studied by means of metabolic balance and bone ash techniques to determine the effect of progressive mineral depletion on the skeleton. A low Ca diet reduced the percentage of Ca in the shell and the reduction became progressively greater with each egg that was laid. Percentage of loss of P was slightly less than the percentage loss of Ca. A certain amount of P mobilized from bone was thought to be retained in the soft tissues. The bones suffering the greatest loss were ribs, sternum, pelvis, coccygeal spine and fibula. The bones that suffered the least were skull, metatarsus and phalanges

of the toes. The bones most severely depleted showed a much greater reduction in the Ca:P ratio than those less depleted." (*Excerpta Med.* 8: 1697.)

533. TAYLOR, T. G., and MOORE, J. H. The effect of calcium depletion on the chemical composition of bone minerals in laying hens. *Brit. Jour. Nutr.* 10: 250-263. 1956.

"In samples of bone tissue from hens which had laid 0, 2, 4 or 6 eggs on a diet containing only 0.054 percent, Ca (Abst. 4874, Vol. 24) Ca, Mg, Na, K, P, carbonate and citrate were estimated. Three types of bone tissue, "non-labile" and "labile" cortical tissue and medullary tissue, from each bird were analyzed.

Depletion of the skeleton, induced by egg production on the low-calcium diet, was associated with increases in Mg, Na, K and P and decreases in Ca, carbonate and citrate contents of bone. The changes were greatest in medullary bone and least in non-labile cortical bone.

It is suggested that the changes were due primarily to increases or decreases of ions adsorbed on the surfaces of bone crystals, and that they reflect changes in the composition of the environment at these surfaces." (*Nutr. Abs. and Rev.* 27: 694.)

534. TYLER, C. Egg shells. IV. Site of deposition of radioactive calcium and phosphorus. *Jour. Sci. Food and Agr.* 5: 335-339. 1954.

"Pullets were fed rations contg. Ca^{45} or P^{32} , and autoradiographs of tangential sections were prepd. of egg shells of eggs laid on subsequent days. The Ca radioautographs showed a distinctive form of layering, which was correlated with time of laying, and it is suggested that the supply of Ca to the shell gland via the blood may consist entirely of either food or bone Ca or of varying proportions of both, depending on the time of day the particular layer of the shell is deposited. The P radioautographs showed that although a little P was spread fairly evenly throughout the shell, most of it was near or on the surface, the surface material perhaps not even being part of the shell." (Chem. Abs. 49: 473.)

535. TYLER, C. The metabolic significance of variations in the shell calcium: Retained calcium relations between individual laying hens. *Jour. Agr. Sci.* 48: 171-174. 1956.

"A statistical analysis was made of data from Ca and P balance expts. for regression equations relating shell Ca to Ca retention. Individual birds gave different regression coeffs. (b values), and over the whole of an expt. the b value and the P balance for each bird were significantly correlated with the total shell Ca secreted by that bird. The metabolic significance of these findings is discussed in relation to shell formation and bone mobilization." (Chem. Abs. 51: 5234.)

FACTORS AFFECTING STRONTIUM AND CALCIUM METABOLISM

DIETARY LEVELS OF CALCIUM AND PHOSPHORUS

536. ARRINGTON, L. R., and DAVIS, G. K. Metabolism of phosphorus³² and molybdenum⁹⁹ in rats receiving high-calcium diets. *Jour. Nutr.* 55: 185-192. 1955.

"A decreased urinary excretion and increased tissue deposition of P^{32} demonstrated a significant retention of P when the intake of Ca was high. Metabolism of Mo^{99} was not changed by the increase in dietary Ca. The rapid elimination of Mo by way of the urine was demonstrated." (Chem. Abs. 49: 7074.)

537. BASSETT, C. F., HARRIS, L. E., and WILKE, C. F. Effect of various levels of calcium, phosphorus and vitamin D intake on bone growth. *Jour. Nutr.* 44: 433-442. 1951.

"In a factorially designed experiment the effects on bone

growth of each of four levels of calcium, phosphorus, and vitamin D and of sex were investigated. One hundred and twenty-eight minks were fed the experimental diets, beginning at a weaning age of 50 days and continuing to the time of pelting at an age of 216 days. X-ray photographs of the humeri were taken at about 125 days of age. The ratio of calcium to phosphorus for a growing mink should be maintained between 0.75:1.00 and 1.7:1.0. The minimum calcium and phosphorus requirement of the growing mink is below 0.3 percent in the dry diet. The vitamin D requirement is less than that supplied by the basal diet (0.82 I.U. per gram of dry food)." (Author's summary.)

538. BASSIR, O. The effect of low calcium diet on tissue metabolism. *Jour. Trop. Med. and Hyg.* 58: 210-216. 1955.

"The liver size of young actively growing rats did not change significantly when the animals were fed diets for

3 weeks that contained amts. of P ranging from very low to optimal. The metabolism of hepatic constituents remained const. Until both the amts. and ratios of Ca and P were satisfactory, wt. increase in young growing animals proceeded at a lower rate than normal. In the 3-wk. feeding regimen increase in the body wt. of young animals could not be stopped by unfavorable amts. and ratios of dietary Ca and P." (Chem. Abs. 50: 4320.)

539. BEAL, V. A. Nutritional intake of children. II. Calcium, phosphorus and iron. Jour. Nutr. 53: 499-510. 1954.

"Data are presented from 795 nutrition histories on 58 children in the first 5 years of life. Ca, P, and Fe intakes were computed in terms of quartiles and maximum and minimum levels observed. Some of the individual patterns of Ca intake are also shown." (Author's summary.)

540. BENZIE, D., and others. The skeleton of the sheep. I. The effect of different levels of dietary calcium during pregnancy and lactation on individual bones. Jour. Agr. Sci. 46: 425-440. 1955.

A. W. Boyne, A. C. Dalgarno, J. Duckworth, R. Hill, and D. M. Walker, joint authors.

"Three groups of mature ewes were fed during pregnancy and lactation on rations differing in their Ca content. The mean daily intakes of Ca were 1.4 g. (group A), 4.5 g. (group B), and 7.4 g. (group C). The level of Ca intake was without effect on the no. of lambs born, birth wt., or growth while milk-fed. Blood Ca was significantly lower in group A than in groups B and C, but blood inorg. P was unaltered. The resorption of bone substance was greater in group A than in groups B and C. The severity of resorption varied between bones and in regions within certain bones. Resorption was accompanied by reductions in the percentages of ash in bones, but this effect was proportionately less than the ash-wt. reduction. Radiological observations made on flesh-free bones at the end of the expt. gave a picture of resorption similar to that presented by the data for ash wts. and percentages of ash." (Chem. Abs. 51: 565.)

541. BENZIE, D., and others. The skeleton of the sheep. II. The relation between calcium intake and resorption and repair of the skeleton in pregnancy and lactation. Jour. Agr. Sci. 48: 175-186. 1956.

A. W. Boyne, A. C. Dalgarno, J. Duckworth, R. Hill, and D. M. Walker, joint authors.

"Cheviot ewes fed a daily ration contg. about 5 g. of Ca during pregnancy and lactation showed a loss of 6.5% of skeletal mineral by mid-lactation and two months after the end of lactation this loss was fully replaced. When the daily Ca allowance was about 2 g. the loss was 18.2% by mid-lactation and was not replaced by 2 months after the end of lactation. Resorption was always more marked in certain bones than others, the cervical vertebrae, skull, and mandible being more sensitive than the ends of the radius and metacarpal and these ends more sensitive than the shafts." (Chem. Abs. 51: 5234.)

542. BLAU, M., and others. Effect of intake level on the utilization and intestinal excretion of calcium in man. Jour. Nutr. 61: 507-521. 1957.

H. Spencer, J. Swernov, J. Greenberg, and D. Laszlo, joint authors.

"Ambulant patients, a man and a woman, were given a low-Ca diet (Bauer and Aub, *J. Amer. Dietetic Assoc.*, 1927, 3, 106) for 74 days. In the first four 6-day metabolic periods they received no Ca supplement; in the next 4 periods the woman received 422 mg. and the man 503 mg. Ca daily as gluconate with meals; in the last 4 periods the Ca supplements were raised to 1339 mg. and 1605 mg. daily. Two days before the start of the first period each patient received with breakfast a single tracer dose of 50 μ c. Ca^{45} in 30 mg. carrier. Endogenous faecal Ca was found to be of the same order of magnitude as urinary Ca, 100 mg. daily, and was independent of Ca intake in both patients. The maximum total Ca in digestive juice was about 150 mg. daily in the woman and 360 mg. in the

man; changes in dietary Ca had little effect on it. About 45 and 65 percent of the dietary Ca was absorbed; good agreement was reached between the values obtained for utilisation of ingested Ca by three methods. The minimum daily Ca requirements under the experimental conditions were calculated to be 8.6 mg. per kg. body-weight for the woman and 3.5 mg. per kg. bodyweight for the man; the values obtained by the metabolic balances and those calculated from the Ca^{45} data were in close agreement." (Nutr. Abs. and Rev. 27: 5278.)

543. BODA, J. M. The influence of dietary calcium and phosphorus on the incidence of milk fever. Jour. Dairy Sci. 39: 66-72. 1956.

"High-producing Jersey cattle, many with previous histories of milk fever, were fed low-Ca, high-P prepartal diets consisting of oat hay and a basal concd. mixt. composed of 40% ground barley, 30% rolled barley, 25% wheat bran, 5% cottonseed meal, and monosodium phosphate (tech. grade). The incidence of milk fever was ascertained. Postpartal serum Ca levels were detd. and and lactation records obtained from most of the animals. Two of 26 cows, 5 with previous histories of milk fever, fed daily ratio of 8 lb. of oat hay and 8 lb. of the concd. mixt. supplemented with 1.5% monosodium phosphate, exhibited symptoms of milk fever. Two of 19 cows (10 with previous histories of milk fever), fed the same ration except for the addn. of 5% phosphate, and only one of 27 cows (12 with previous histories of milk fever), fed a daily ration of 5-6 lb. of oat hay and 10-12 lb. of the 5% phosphate, supplemented concd. mixture, developed milk fever. All three prepartal rations allowed adequate wt. gains before parturition and had no adverse effects upon parturition, the subsequent lactation records, or the health of the calves." (Chem. Abs. 50: 5872.)

544. CARLSSON, A. Metabolism of radiocalcium in relation to calcium intake in young rats. Acta Pharmacol. et Toxicol. 7 (sup. 1), 74 p. 1951.

"Young rats which had been fed a low Ca diet for 3 weeks or more retained a much higher proportion of an orally administered dose of Ca^{45} (given as lactate) than did rats which had received adequate Ca in their diet. After subcutaneous injection of Ca^{45} it was almost completely retained in the body during the first 18 hrs. irrespective of the level of Ca in the diet. Parenteral administration of Ca lactate increased the uptake of ingested Ca^{45} from the digestive tract, probably because of inhibition of gastrointestinal movements. The effect of previous Ca deprivation on the uptake of Ca^{45} persisted unaffected. Adult rats absorbed much less Ca^{45} from the intestine than did young rats. In young rats fed diets of varying casein content there appeared to be no close relation between absorption of Ca^{45} and rate of growth. Linear relation was found between the relative quantities of Ca^{45} taken up in the femurs and incisors and the relative body growth. In rats deprived of dietary Ca the incisors, unlike the bones, continue to retain an almost normal amt. of Ca; this results in a drop in the femur/incisors ash ratio. On the other hand, the Ca^{45} ratio of femur/incisors was the same in Ca-deprived rats as in normal rats. In rachitic rats there is a marked decrease of the Ca^{45} femur/incisors ratio as detd. 18 hrs. after administration of Ca^{45} . No significant effect of supplementation with vitamin D on the retention of orally administered Ca^{45} could be noted in the body as a whole, or in the femurs and incisors, in rats reared on a low-Ca or high-Ca diet. During the first day after peroral administration of Ca^{45} to normal growing rats the long bones took up more Ca^{45} than did the incisors; later the reverse was true." (Chem. Abs. 45: 9645.)

545. CATSCH, A. The influence of isotopic and nonisotopic carriers on the distribution of radiostrontium in the rat. Experientia 13: 312-313. 1957.

" Sr^{90} in the skeleton of female rats weighing 115 to 135 g. was measured 2 days after intraperitoneal injection of carrier-free Sr^{90} - Y^{90} without or with Ca or Sr as chloride or Mg as chloride or sulphate. The logarithm of the Sr^{90}

content of the skeleton was linearly related to the logarithm of the dose of carrier. Sr in relatively small amount had a significant effect; that of Ca was doubtful; Mg in small amount had less effect than Sr but in larger amounts much more than Sr. It was concluded that neither Ca nor Mg can act as a biological carrier for Sr^{90} ." (Nutr. Abs. and Rev. 28: 854.)

546. CHAPMAN, D. G., and CAMPBELL, J. A. Effect of bone meal in enriched flour on the utilization of iron by anaemic and normal rats. *Brit. Jour. Nutr.* 11: 133-137. 1957.

"In the third experiment normal and anaemic rats were fed for 20 weeks on a diet containing 80% bread made from flour unenriched, enriched with Fe and vitamins or with Fe, vitamins and bonemeal. One of the flours contained 2.78 and the other 3.86 Mg. Fe per 100 g. In normal rats on the diet with the lower Fe content, enrichment increased Fe storage in the liver; bonemeal had no effect. With the bread of higher Fe content enrichment did not cause a significant increase in the Fe content of the liver over that on the unenriched bread and again bonemeal had no effect. With anaemic rats on the bread with lower Fe content, enrichment caused a marked increase of storage of Fe; bonemeal had no further effect. The enriched breads regenerated Hb more quickly than the unenriched in both normal and anaemic rats; the presence of bonemeal had no adverse effect." (Nutr. Abs. and Rev. 27: 5276.)

547. CHAPMAN, D. G., and CAMPBELL, J. A. Effect of bone meal on the utilization of iron by anaemic rats. *Brit. Jour. Nutr.* 11: 117-126. 1957.

"The introduction in Canada of enriched flour containing edible bonemeal or calcium carbonate prompted the following experiments to study their effect on utilization of Fe.

Groups of anaemic rats initially 35 days old were fed for 10 weeks on a basal unenriched ration, chiefly bread, containing on the average 2.25 mg. Fe and 317 mg. Ca per 100 g.; other groups received their bread fortified with from 10 to 200 mg. ferrous sulphate per lb. flour, along or with bonemeal, 1.5 or 7.5 g. per lb. to give Fe levels of 2.98, 3.52, 5.07, and 14.82 mg. and Ca^{40} s and 733 mg. per 100 g. diet. Increase of Fe intake produced a significant increase of food consumption and of bodyweight gain, unaffected by the presence of bonemeal. The addition of Fe increased Fe storage in the liver and again the presence of bonemeal had no significant effect, although there was an indication that high amounts decreased Fe storage. Sex had a significant effect on storage. Relative heart weight was reduced with increase of Fe intake and the addition of bonemeal did not affect this result. With 2.98 or 3.52 mg. Fe in the diet there was marked improvement of Hb regeneration from an initial level of 6.0 g. to 14 g. per 100 g. after 10 weeks; with still higher intake Hb rose to 16.0 g. per 100 g. in the same time. High levels of bonemeal tended to retard Hb regeneration on low Fe intake, but on high Fe intake the presence of bonemeal had no effect on Hb regeneration." (Nutr. Abs. and Rev. 27: 5276.)

548. [No reference.]

549. CHAPMAN, D. G., and CAMPBELL, J. A. Effect of calcium and phosphorus salts on the utilization of iron by anaemic rats. *Brit. Jour. Nutr.* 11: 127-133. 1957.

"Further experiments were made to find whether the Ca or phosphate portion of bonemeal caused the interference with utilisation of Fe when relatively high amounts of bonemeal were added to bread diets low in Fe. The same basal ration was used, but one variation contained 2.43 and the other 3.56 mg. Fe per 100 g.; Fe was added to each (10 mg. FeSO_4 per lb. flour) to bring the levels to 3.00 and 4.15 mg. per lb. diet. The further additions were of bonemeal, calcium carbonate, calcium lactate, calcium chloride, disodium phosphate and commercial sodium hexametaphosphate, alone or with the additional Fe. The Ca and P salts were added to give Ca and P levels corresponding to those used in the first experiment, in which the

level of bonemeal was highest. Anaemic rats were used and the experiment lasted for 10 weeks. CaCO_3 and CaCl_2 reduced food intake and consequently Fe intake; the other Ca salts did not. CaCO_3 , CaCl_2 , and Ca lactate all decreased weight gain. Bonemeal and all the Ca salts decreased storage of Fe in the liver, and all forms of Ca increased relative heart weight and retarded Hb regeneration; the result with Ca was not affected by the addition of the small amount of Fe. Disodium phosphate increased food intake, but hexametaphosphate did not. Neither phosphate affected weight gain, Fe storage, or Hb regeneration. Hexametaphosphate did not affect heart weight gain, but disodium phosphate increased it. Since large amounts of Ca affected utilization of Fe but phosphate did not, it is suggested that the mucosal cells became saturated with Ca and blocked further absorption of Fe." (Nutr. Abs. and Rev. 27: 5276.)

550. FRENCH, R. B., ABBOTT, O. D., and TOWNSEND, R. O. Relation of calcium, phosphorus, and protein deficiencies in the immature rat to defects in growth and skeletal development of the mature animal. *Fla. Univ. Agr. Expt. Sta. Bul.* 569, 36 p. 1955.

"Weanling rats fed a bread diet for 13 weeks developed short femur bones. The addn. of Ca- or P-contg. salts prevented development of the short femur. Rats fed a diet contg. purified lactalbumin and free from Ca and P developed symptoms of Ca and P deficiency. Data on abnormalities in bone structure were demonstrated by comparison with data on normal structure obtained from curves that related femur/body lengths and pelvic girdle measures/innominate lengths in animals of the stock colony." (Chem. Abs. 50: 11458.)

551. GOTO, T., IKEDA, M., and EBIHARA. Metabolism of the calcium and phosphorus of the food fortified with calcium. *Kasei-gaku Zasshi* 8: 39-41. 1957.

"A group of rats received Ca-fortified food (twice as much as the control group) and excreted 3 times as much Ca as the control group. The Ca contents of the bone and liver were found to be less than those of the control group after a 12-day period. No differences in P excretion in feces were observed between the test and control groups but the P contents in the bone and liver were found to show the same pattern of decrease as observed with Ca." (Chem. Abs. 52: 1394.)

552. GROSS, W. J., TAYLOR, J. F., and WATSON, J. C. Factors influencing the metabolism of radiostrontium by animals. *U.S. Atomic Energy Comm. UCLA-274*, 20 p. 1954.

"Five groups of 5 rats each received by stomach tube 1, 2, 10, 50, and 100 times the normal daily intake of stable Sr (0.45 mg.) mixed with Sr^{90} and Y^{90} , daily for 7 consecutive days. The animals were sacrificed 24 hrs. after the final dose, and tissues were assayed radiologically. The amt. of stable Sr did not alter the uptake of Sr^{90} the av. deposition varying from 4.0 to 4.9% of the dose for the varying groups. When pellets contaminated with Sr^{90} and Y^{90} were fed to rats, starting at 4 weeks of age, the percentage of the dose deposited decreased from 7.9% at the beginning to 1.8% after 36 weeks. A similar decrease was seen in 5 adult rats fed Sr^{90} and Y^{90} for 18 weeks." (Chem. Abs. 48: 8922.)

553. HANSARD, S. L., COMAR, C. L., and PLUMLEE, M. P. Effect of calcium status, mass of calcium administered and age on Ca^{45} metabolism in the rat. *Soc. Expt. Biol. and Med. Proc.* 78: 455-460. 1951.

"The fecal excretion of orally administered Ca^{45} is a sensitive indication of the Ca status of the rat. Placing normal rats on a low-Ca diet for as little as 2 days greatly increased their ability to absorb Ca^{45} from the digestive tract. In general, younger rats absorbed more Ca^{45} than did older ones although there was no significant difference between 6½- and 16-month-old rats. For significant studies of this type, interpretations must include consideration of exchange reactions, and care must be given to the initial selection of animals and the dietary management during the exptl. period." (Chem. Abs. 46: 2139.)

554. HANSARD, S. L., and PLUMLEE, M. P. Effects of dietary calcium and phosphorus levels upon the physiological behavior of calcium and phosphorus in the rat. *Jour. Nutr.* 54: 17-31. 1954.

"The behavior of labeled Ca and P was studied as a function of the dietary levels of these elements. Data obtained with more than 250 growing rats are presented. Balance data appear to be basic for the interpretation of the behavior of Ca^{45} and P^{32} in the animal body. These simple procedures for estimates of endogenous Ca suggest application to studies of other factors involved in the physiol. behavior of these minerals in animals." (*Chem. Abs.* 49: 2577.)

555. HARRISON, G. E., JONES, H. G., and SUTTON, A. The effect of carrier strontium on the absorption of oral doses of radioactive strontium in rats. *Brit. Jour. Pharmacol.* 12: 336-339. 1957.

"Carrier strontium had relatively little effect on the retention of an oral dose of radioactive strontium by the rat when it was administered immediately after the radioactive dose. The proportion of the radioactive dose that was excreted in the urine, on the other hand, increased progressively with the carrier dose. There was a decreased uptake of radioactive strontium in rats fed on a special low strontium diet. The effects of dietary strontium are discussed. Evidence was found of a discrimination by the rat against strontium in favor of calcium that was accounted for, at least in part, by a preferential urinary excretion of strontium." (Author's summary.)

556. ITO, Y., and others. Detoxification and excretion of radioactive strontium. I. Effect of dihydrotachysterol and diets deficient in calcium, phosphorus, or both. *Yakugaku Zasshi* 78: 76-82. 1958.

S. Tsurufuji, M. Shikita, and Y. Matsushima, joint authors.

"In order to investigate the effect of abnormal dietary Ca and P on the excretion of radioactive Sr (I), (Sr^{90} + XY^{90}), rats about 2 months old were fed diets low in P (0.187%), low in Ca (0.011%), and low in P and Ca (0.189% P and 0.015% Ca), and on a normal control diet (0.582% P and 0.601% Ca). The rats were injected subcutaneously with I and then orally given dihydrotachysterol (II). In addn. to the metabolism of I, Ca and P metabolism were examd. In the group of low-Ca diet and low-Ca P diet rate of I excretion was not markedly changed, though Ca balance had become neg. and the amt. of Ca in carcasses was reduced. Greatly enhanced excretion of I, mainly into urine, was observed in the group on low-P diet. In the low-P group no decrease of carcass Ca was observed, though a slight decrease in Ca retention was found. Therefore, it is evident that normal bone structure was not markedly injured in this group. Active excretion of I in the group on low-P diet seems to be related to increased activity of urinary excretion of Ca and to active absorption of Ca in the intestine. Skeletal disturbances in low-Ca and in low-Ca-P diets fail to decrease I accumulation into skeleton. II did not have any significant effect on I excretion." (*Chem. Abs.* 52: 6520.)

557. JOHNSTON, F. A., TREDWELL, C., and DIAO, E. Effect of previous calcium intake of four young men on amount retained from a low calcium diet. *Fed. Proc.* 15: 559. 1956.

"Four college men who had been living on diets estimated to contain approximately 2,000, 1,500, 750, and 450 mg. of calcium a day, according to a week's dietary record, were placed on a diet containing slightly less than 200 mg./day. The study extended over five 4-day collection periods, the first of which served for adjustment. The first subject excreted in feces and urine a mean of 218 mg. of calcium/day more than was contained in his food. The second subject started with a negative balance of 127 mg./day and then lost less during each successive period until during the last 4 days he lost only 35 mg./day. The third subject, for whom only one urinary value was obtained, appeared to be about in equilibrium. The fourth subject retained 92 mg./day. Although this in-

dicates that the previous diet exerts a control over the amount of calcium retained, the number of subjects is too few for the drawing of a valid conclusion. More cases will be studied." (Author's abstract.)

558. KANE, G. G., and McCAY, C. M. Calcium requirements of old and young hamsters and rats. *Jour. Gerontol.* 2: 244-248. 1947.

"On an adequate basal diet contg. 0.4% P and 0.3, 0.5, or 0.7% Ca rats and young hamsters 43-52 days old absorbed 88 and 78% of the Ca, resp. Animals 500-600 days old were at a negative balance on the diet contg. 0.3% Ca and in balance when they received the diets contg. 0.5% or more Ca." (*Chem. Abs.* 42: 2335.)

559. KANEMATSU, S. The calcium metabolism of normal individuals on a low calcium diet. *Eiyô to Shokuryô* 5: 225-242. 1953.

"Expts. were made with 5 healthy adults, for 18 days, which consisted of the preparatory period of high-Ca diet (1.5-1.7 g. per day), and the low-Ca period (0.10-0.15 g.) with varied P contents (0.4 or 0.8 g.) or varied fat content (7.5 or 72 g.). Ca and P metabolisms were examd. chiefly by detg. them in feces and urine. The abrupt decrease of Ca intake decreased greatly the excretion of Ca both in urine and feces. The amt. of Ca excreted into urine did not change in proportion to the intake; most of Ca excreted was presumed to be the result of metabolism independent of the amt. of Ca intake. The excretion of Ca into feces varied nearly in proportion with the intake. The rate of absorption of Ca was not small when the diet was low in Ca. In the expt. of injection of CaCl_2 or Ca gluconate, 70-80% of Ca in the case of high-Ca or 50-70% of Ca in the case of low-Ca was excreted into urine within 24 hrs. The injection of Ca did not increase the excretion of P into feces, and decreased the excretion of P in urine. The effects were not clear of the intake of P and fat on Ca in the low-Ca diet. 41 ref." (*Chem. Abs.* 51: 18169.)

560. KONO, T. Calcium in foods. I. Calcium content of the diet. *Eiyô to Shokuryô* 5: 143-146. 1952.

"Actual detn. showed that the daily intake of Ca was 271-375 mg. in the summer and 565-729 mg. in the winter. The Ca intake was higher on a diet contg. small fish with edible bones. Ca in rice was 15-20% of the daily intake of Ca." (*Chem. Abs.* 51: 18169.)

561. LIU, C. H., ASHTON, G. C., and CATRON, D. V. The effect of intermittent consumption of calcium in rats. *Jour. Nutr.* 59: 267-271. 1956.

"Four groups of 6 weanling rats were given a basal diet containing 0.019 per cent Ca and 0.445 per cent P and consisting of maize starch 55.7, sucrose 15, crude casein 18, maize oil 4, salt mixture without Ca and P 3, cellulose 2, irradiated yeast 1, and monobasic potassium phosphate 1.3 per cent., fortified with all known vitamins of the B group and cod liver oil. During the first 2 weeks of the 6-week experiment the rats received 10 g. daily of the basal diet; one group received 20 mg. daily, the second 40 mg. every second day, the third group 80 mg. every fourth day, and the fourth group 120 mg. every sixth day. The basal ration was then increased from 10 to 15 g. daily and the supplementary Ca was increased by 50 per cent. After 4 more weeks the rats were killed and femurs were removed for estimation of Ca and P. The intermittent provision of CaCO_3 did not affect the gain in weight appreciably. The femurs of the rats which had received daily Ca had the greatest air-dry weight, ash weight, and total Ca and P contents. The average percentages of Ca in the femur ash were 35, 33, 32, and 28 per cent. The average percentages of P in the femur ash bore no relation to the length of the interval between doses of Ca." (*Nutr. Abs. and Rev.* 27: 699.)

562. MacDONALD, N. S., and others. Effects of calcium and phosphate in foods on radiostrontium accumulation. *Jour. Nutr.* 57: 555-563. 1955.

P. C. Spain, F. Ezmirlian, and D. E. Rounds, joint authors. "The radioactivity of the bones was reduced when

increased levels of Ca and P were fed with Sr^{90} (+ Y^{90}) with common foods. Using Sr^{90} as a Ca tracer the % of an oral dose of Ca which deposits in the skeleton decreases as the size of dose increases. "The metabolic fates of Ca and Sr seem very similar." (Internatl. Abs. Biol. Sci. 4: 4071.)

563. MATTERN, H., and SCHREIER, K. Studies on calcium metabolism with Ca^{45} . 2. The effect of polyphosphates on absorption and retention of Ca, according to experiments with Ca^{45} . *Ztschr. f. die Gesam. Expt. Med.* 128: 103-108. 1956. [For parts 1 and 3 see *Nutr. Abs. and Rev.* 27: 2195 and 3771.]

"2. Rats were given 10 or 20 mg. Ca^{40} + Ca^{45} by stomach tube in the form of CaCl_2 with different amounts of sodium polyphosphates, and were killed 18 or 36 hr. or 10 days later. Total amount of Ca absorbed and amount of Ca in serum, bones, teeth, and urine were estimated. Ten mg. pyrophosphate, tripolyphosphate or hexametaphosphate (Graham's salt) had no influence on absorption or retention of Ca. Daily administration of 10 or 20 mg. Graham's salt for 10 days did not influence deposition of Ca in bones and teeth. Sodium citrate had no definite influence on absorption of Ca when it was given with the polyphosphates." (*Nutr. Abs. and Rev.* 28: 849.)

564. MENDEN, E., and CREMER, H. D. Effect of water from mineral springs on the resorption, deposition, and retention of calcium by the bones and teeth. *Medizinische* 10: 353-354. 1956.

"As sources of drinking water, 1 group of 6-8 week-old rats received water from a mineral spring, and another group distd. H_2O supplemented with Ca equal to that of the mineral water. All animals were given 33.3 mg. CaCO_3 marked with Ca^{45} /day for 6 days. They were killed at intervals. The Ca^{45} compn. of the bones and teeth indicated the Ca resorption and deposition were equal in both groups. The retention was also equal at 2-4 weeks, but at 6, 8, and 10 weeks, significantly more Ca^{45} was found in the bones and teeth of the rats receiving the mineral water." (*Chem. Abs.* 50: 8103.)

565. MOURIQUAND, G., and NOGIER, A. L. Fixation of Sr in experimental rickets. *Soc. de Biol. [Paris] Compt. Rend.* 106: 8-9. 1931.

Sr was found in normal bony tissue of rats and fixed only irregularly and in infinitesimal traces in this tissue when young rats were fed a diet containing 2.2 percent of SrCO_3 . However, the weight of epiphyses ash of young rats fed on this diet is always notably greater than that of young rats fed on Sr-free diet.

566. NAKAJIMA, T., and SUGITA, T. Influence of feed upon bones. I. Chemical components of bone of developing rats and influence of feed supplemented with calcium on its composition and development. *Jap. Jour. Vet. Sci.* 12: 13-22. 1950.

"The basal diet fed to 30-day old rats consisted of 50% corn, 15% millet, 13% soy bean cake, 10% wheat bran, 8% fish meal, 3.5% oyster shell, and 0.5% NaCl. It contained 16.61% crude protein, 3.58% crude ash, 0.45% Ca, and 0.86% P, the P:Ca ratio being 1:9. The rats in the 1st expt. were fed the basal diet for 0, 60, 80, or 110 days. Body growth was recorded and each group was subjected to bone analysis. In the 2nd expt. the basal diet was supplemented with CaCO_3 to provide P and Ca at a ratio of 0.67. In the 3rd expt. CaCO_3 was added to a ratio of P:Ca of 0.05. Dry matter of the bones increased directly with body development, water decreased, and Ca and P content increased. The compn. of the bones of rats examd. on the 60th and 80th days of the expts. was normal. The relative amt. of Ca and P in the ash was proportional to the Ca and P in $\text{Ca}_{10}\text{CO}_3(\text{PO}_4)_6$. Ca content in the bone ash on the initial day of the test was lower than this, but on the 110th day it was higher. Apparently the degree of Ca deposition gradually increases with age. When excess Ca is supplied, relatively more Ca than of other bone components is deposited." (*Chem. Abs.* 49: 7671.)

567. NATUCCI, G. Ca, P, and alkali reserve in the rachitiform osteopathy caused by Sr biochem. *Biochim. e Terapia Sper.* 22: 385-389. 1935.

Rabbits receiving Sr lactate by mouth develop a bone disease resembling rickets. The Ca in the blood increases, the P decreases, and the alkali reserve diminishes.

568. NEUMAN, W. F., and others. Deposition of uranium in bone. III. The effect of diet. *U.S. Atomic Energy Comm. AEC D-1917*, 4 p.; *Jour. Biol. Chem.* 175: 705-709. 1948.

M. W. Neuman, E. R. Main, and B. J. Mulryan, joint authors.

"Rats given several injections of uranyl nitrate were divided into groups and placed on different exptl. diets for a period of 50 days. A rachitogenic diet was found to increase the rate of removal of skeletal U. Acidic and alk. diets did not significantly alter the rate of removal of U from the skeleton. A study *in vitro* of the equil. of bone ash with uranyl bicarbonate has shown that high concns. of HCO_3^- inhibit the uptake of U by the ash. Apparently it is not possible to alter the compn. of the body fluids enough to increase the rate of removal of U *in vivo*. The half life of skeletal U in the rat is of the order of 50-60 days." (*Chem. Abs.* 43: 1114.)

569. NICOLAYSEN, R. Studies in calcium metabolism in rats. III. Adaption to low Ca intakes of old rats. *Acta Physiol. Scand.* 36: 114-118. 1956.

"The Ca balance of thirty-three old rats was studied until death. The animals could stay in balance on a diet consisting of 0.04% Ca, and did not go into neg. Ca balance until just preceding death." (*Chem. Abs.* 50: 14899.)

570. RAY, R. D., STEDMAN, D. E., and WOLFF, N. K. Bone metabolism. III. The effect of various diets on the mobilization of strontium from the rat skeleton. *Jour. Bone and Joint Surg.* 38-A: 637-654. 1956.

"A study has been carried out to determine the effect of various diets on body growth, histological structure of bone, and chemical composition and mobilization of Sr from the skeletons of young growing rats. Animals having from 5 to 6% of the mineral portion of their skeletons as Sr were maintained on a standard laboratory diet, a low-protein diet, a high-calcium and high-vitamin D diet, a subminimal-phosphorus diet, a cereal rachitogenic diet, a cereal rachitogenic diet containing ammonium chloride, and a low-phosphorus diet. The low-phosphorus diet had the most profound effect on Sr mobilization and skeletal mineralization, while the standard diet and the low-protein diet had the least effect." (*Nuclear Sci. Abs.* 10: 9915.)

571. RUBANOVSKAYA, A. A., and USHAKOVA, V. F. Effect of daily injection into the stomach of non-radioactive strontium lactate and magnesium sulfate on the elimination from the skeleton of deposited radioactive strontium. *Mater. Toksikol. Radioaktiv. Veshch.* (Moscow: Gosud. Izdatel. Med. Lit.) Sborn. 1: 197-200. 1957.

"White rats were administered at once or in 2 applications Sr^{90} at the rate of 1.7 mc. by way of the stomach. This was followed by the administration of 50 mg. non-radioactive Sr lactate or 15 mg. MgSO_4 per rat daily for 12 or 43-53 days. In isolated instances a slight increase in the elimination of the Sr^{90} was observed following the administration of the Sr lactate; the administration of the MgSO_4 appeared to have delayed the elimination of the Sr^{90} in some isolated instances." (*Chem. Abs.* 52: 3151.)

572. RYGH, O. Trace elements. I. Importance of Sr, Ba, and Zn (in the animal organism). *Soc. de Chim. Biol. Bul.* 31: 1052-1061. 1949.

"Exptl. diets contg. very small quantities of 40 elements are described. Small amts. of Sr, Ba, and Zn appear to be indispensable for rats. Sr stimulates deposition of Ca in the bones and teeth of rats and guinea pigs; Ba and Zn retard Ca deposition. In scorbutic guinea pigs Sr intensifies the abnormal calcification in the pulp cavities of the teeth; Ba and Zn have the opposite effect." (*Chem. Abs.* 44: 3104.)

573. RYGH, O. Trace elements. II. Biological importance of thallium, vanadium, silicon, and fluorine. *Soc. de Chim. Biol. Bul.* 31: 1403-1407. 1949.

"In rats, deposition of Ca in the bones is favored by small amts. of Sr and V in the diet. Decalcification of the bones is promoted by small amts. of Tl plus either Zn or Ba. Si and F have no role in animal metabolism." (*Chem. Abs.* 44: 6497.)

574. SAARINEN, P. A statistical study of the effect of excessive feeding of calcium and phosphorus supplements on the blood calcium and phosphorus of dairy cows. *Maataloustiet. Aikakausk.* 22: 122-131. 1950.

"A statistical study of the effects of the feeding of large amounts of calcium and phosphorus supplements on the level of these minerals in the blood of dairy cows was made on the basis of 274 blood samples collected from 15 herds. The effects of four presumably independent variables—the actual amount of either calcium or phosphorus in the ration, milk yield, stage of lactation, and the Ca/P ratio of the ration—were investigated simultaneously. When the level of calcium in the blood (x_1) was considered as the dependent variable, it showed a possibly significant correlation only to two of the above-mentioned independent variables, e.g., to Ca/P ratio (x_2) and milk yield (x_3). When the effect on the level of inorganic phosphorus in milligrams per 100 ml. of blood (x_1) was investigated similarly, again only two of the variables studied, e.g., the actual amount of phosphorus (grams per day) in the ration (x_2) and the milk yield (x_3) appeared to be effective. When the cations Na^+ , K^+ , and Ca^{++} and the anions Cl and HPO_4 were determined separately in the blood, the total amount of cations expressed in chemical equivalents exceeded the total equivalent amount of inorganic anions to an amount that was about twice the equivalent amount of the bicarbonate alkali reserve of the blood. The total cation excess varied independently of the Ca/P ratio of the ration, but the latter showed a negative correlation to the bicarbonate alkali reserve, probably due to an increasing amount of organic acids in the blood. No effect on the pH of either blood or feces was noticed. It is concluded that an excessive amount of phosphate may be conducive to maintaining a high blood inorganic phosphate level. Similarly, a high Ca/P ratio of the ration or an excessive amount of calcium carbonate in the feed, along with proper rumen fermentation, may be conducive to maintaining a high calcium content in the blood of high producing dairy cows." (Excerpt from author's summary.)

575. SAGER, R. H., and SPARGO, B. The effects of a low-phosphorus ration on calcium metabolism in the rat with the production of calcium citrate urinary calculi. *Metabolism, Clin. and Expt.* 4: 519-530. 1955.

"The effects of a diet contg. normal amts. of Ca and only 0.03% P were studied in adult, male protein-depleted rats. X-ray examn. of the skeleton, detn. of size of the parathyroid glands, and balance studies indicated that intestinal absorption of Ca increased, accompanied by elevated non-protein-bound plasma Ca and increased urinary Ca and citrate excretion. Hypoproteinemia intensified the results. Citrate appears to be drawn from the Krebs cycle as a compensatory mechanism, to combine with excess blood Ca and thus to maintain ionized Ca within tolerable limits. The high urinary concns. of Ca and citrate result in the pptn. of Ca citrate urinary calculi after 6 days. The results are interpreted as representing a secondary response to an increased absorption of dietary Ca in the presence of lowered dietary P. It is suggested that when a low-P diet without limitation of Ca is used as a treatment for renal stones, the increased absorption and excretion of Ca may increase the possibility of calculus formation." (*Chem. Abs.* 50: 13213.)

576. SCHRAER, H., and SCHRAER, R. Quantitative measurements of bone density changes in rats fed diets of different calcium content. *Fed. Proc.* 15: 571-572. 1956.

"The degree of accuracy with which the mineral content of bone can be measured has been markedly improved by

the development of a bone density computing machine (Brown Natl. Electron. Conf. Proc. 5, 1949). Diaphyses of rat femurs were removed, cleaned, dried, and X-rayed with an aluminum alloy wedge in juxtaposition. The films were evaluated for X-ray mass and compared with ash weights of corresponding bone samples. A correlation ratio of 0.98 was obtained. Later 30 weanling rats received a low calcium diet, and 20 received a diet adequate in calcium. The animals were X-rayed with the wedge and killed, some at 36 days and thereafter at 7-day intervals for several weeks. Rats fed Purina Dog Checkers were used as controls. The films were evaluated for bone density at the midpoint of the femur. Bone density values increased slowly on the low calcium diet and more rapidly on the control Checker diet and the diet adequate in calcium. After 64 days animals on the low calcium diet received a supplement of calcium as calcium carbonate. Films of animals on the supplemented diet showed a marked increase in bone density values. This increase was observed at 7 days by photodensitometric measurements. The magnitude of density increase observed indicated that the density change could have been detected much sooner." (Author's abstract.)

577. SHERMAN, H. C., and others. Influence of protein and calcium addition to already adequate diet. *Natl. Acad. Sci. Proc.* 46: 682-687. 1956.

C. S. Pearson, M. E. R. Bal, A. McCarthy, and C. S. Laford, joint authors.

"Rats fed on a uniform diet consisting of 1/6th dried whole milk and 5/6th ground whole wheat with salt and distilled water have thrived for over 80 generations. Experiments with the diet supplemented by extra protein either alone or with simultaneous increase of Ca content showed that the most beneficial level of Ca intake when the protein intake was liberal is in the range of 0.4%-0.6% (2-3 times min. adequacy). It is concluded that a diet liberal in both Ca and protein is superior to a diet liberal in protein alone." (*Internatl. Abs. Biol. Sci.* 7: 741.)

578. SOBEL, A. E., and BURGER, M. Calcification. XIII. The influence of calcium, phosphorus, and vitamin D on the removal of lead from blood and bone. *Jour. Biol. Chem.* 212: 105-110. 1955.

"In rats with exptl. Pb poisoning, a high-Ca, low-P diet produced the most rapid loss of Pb from the skeleton and the highest blood-Pb level. A high-P, low-Ca diet produced the slowest loss of Pb and the lowest blood-Pb level. The addn. of vitamin D to the diets produced (a) a decrease in blood Pb, (b) a decreased loss of bone Pb, (c) a rise in the serum Ca X P product, (d) an increase in the percentage of ash in bone, and (e) an increase in wt. of all the rats. Vitamin D given during Pb administration enhanced Pb absorption and increased blood Pb. After Pb administration ceased, vitamin D, to the degree that it increased serum phosphate, depressed blood Pb. The high-Ca, low-P diet, by decreasing serum phosphate, caused a concomitant rise in blood Pb at the expense of bone Pb. In the high-P, low-Ca diet the resulting rise in serum phosphate was paralleled by a low-blood-Pb level and decreased loss of bone Pb. High blood Pb is accompanied by low serum P and vice versa, but there is no simple reciprocal relation. In human studies, intravenous injection of Ca gluconate increased the blood Pb. This principle was used to detect the existence of high Pb storage. The patient was placed on a high-Ca, low-P diet, and blood Pb was detd. subsequently." (*Chem. Abs.* 49: 4824.)

579. SVENSSON, S. A. Skeletal retention of injected radiophosphate in chicks kept on feeds of different phosphate content. *Nature* 179: 972-973. 1957.

"Chicks fed a lower-phosphate level feed showed no difference in growth than those fed a high-phosphate level feed but showed a higher retention of radiophosphate after it was deposited in the bone tissues." (*Chem. Abs.* 51: 16765.)

580. URIST, M. R., and McLEAN, F. C. Accumulation of mast cells in endosteum of bones of calcium-

deficient rats. Amer. Med. Assoc. Arch. Path. 63: 239-251. 1957.

"In newly weaned rats given a diet low in Ca and in vitamin D (Shohl's diet E: see Abst. 627, Vol. 6) for 4 or 5 weeks, large numbers of mast cells were found round and within the endosteum. Mast cells in mesentery, perivascular connective tissue of muscle and synovial membrane were normal in number. Histological evidence of rickets, osteoporosis and osteitis was found. During treatment for one week with large doses of vitamin D rickets began to heal and the number of mast cells was reduced." (Nutr. Abs. and Rev. 27: 4809.)

581. WALKER, A. R. P., and ARVIDSSON, U. B. Human bone from South African Bantu subjects. I. Chemical composition of ribs from subjects habituated to a diet low in calcium. Metabolism, Clin. and Expt. 3: 385-391. 1954.

"Effects of a diet low in vitamin D and Ca, and high in P on bone mineralization in infants, children, and adults were detd. by assaying rib samples for percentage of ash, Ca, and P. Comparable bone from European subjects on adequate diets served as controls. Analyses were made on dry, defatted (and occasionally marrow-free) bone according to methods described in (McCance and Shipp, *The Chemistry of Flesh Foods and Their Losses on Cooking*, 1933, 146 pp. (C.A. 28, 2427)). If infants dying of rickets were excluded no significant differences were found between percentage compn. of ribs of infants of both races, children of both races, or adults of both races. Mineralization was low in infants dying of rickets, but was normal in those dying of malnutrition." (Chem. Abs. 49: 1166.)

582. WASSERMAN, R. H., COMAR, C. L., and PAPADOPOULOU, D. Dietary calcium levels and retention of radiostrontium in the growing rat. Science 126: 1180-1182. 1957.

"Higher levels of dietary calcium did not greatly alter the total feed ingested, the body weight, or the ash content of the carcass. However, as the calcium level in the diet increased, the retention of Sr^{85} , as well as that of Ca^{45} , was reduced. In rats maintained on diets containing either 0.5 percent, 1.0 percent, or 2.0 percent of calcium for 15 days, a fourfold increase in calcium intake resulted in about a threefold decrease in radiostrontium retention. After 45 days on these diets, this relationship was nearly proportional, since each twofold increase in calcium ingestion gave about a twofold depression in the retention of Sr^{85} . These differences would suggest that the rat requires more than 15 days and less than 45 days to adapt fully to the different levels of calcium intake." (Author's summary.)

583. WILLIAMS, D. E., and others. Influence of mineral intake on bone density in humans and in rats. Jour. Nutr. 61: 489-505. 1957.

B. B. McDonald, E. Morrell, F. A. Schofield, and F. L. MacLeod, joint authors.

"Bone density, measured on X-ray photographs of the os calcis, of young adults was correlated with estimated intake of Ca during the years of growth, but was not altered by increase of intake for 3 months. Densities of the caudal vertebrae of young rats given diets containing 0.1, 0.3, or 0.5 percent Ca for 6 to 7 weeks were 0.39, 0.60, and 0.67. The specific activities of bones taken from these rats 3 days after Ca^{45} was given by mouth were inversely related to intake of Ca. The density of bone of rats reared on a stock diet and fed thereafter for about 9 months on diets containing 0.1, 0.3, or 0.5 percent Ca was not affected by intake of Ca after maturity was reached." (Nutr. Abs. and Rev. 27: 5280.)

584. WORTON, A. G., BYERS, T. E., and GILLINGHAM, J. E. Comparative evaluation of calcium glycerophosphate as a dietary calcium supplement. Ohio State Med. Jour. 52: 1040-1044. 1956.

"Female mice were fed a basic diet contg. 0.5% Ca as the carbonate, lactate, di- or triphosphate, or glycerophosphate (I) for 6 weeks. The mice fed I had a higher degree

of bone calcification and strength than did those fed the other Ca compds. or those on the basic diet only. I was sol. throughout the pH range of the gastrointestinal tract, whereas the other compds. were relatively insol. at pH 6 of the duodenum and pH 8 of the ileum when the phosphate concn. was similar to that attained with I. 30 references." (Chem. Abs. 51: 5938.)

VITAMINS

Vitamin D

585. BELLIN, S. A., and others. The effect of vitamin D on urinary citrate in relation to calcium, phosphorus and urinary pH. Arch. Biochem. and Biophys. 50: 18-24. 1954.

D. C. Herting, J. W. Cramer, V. J. Pileggi, and H. Steenbock, joint authors.

"Vitamin D increased the amount of urinary citrate excreted by young rats kept on rations varying widely in mineral content. These rations ranged in composition from those providing an adequate mineral intake to those made grossly deficient in Ca, P, and other minerals. The biggest percentage increase in citrate was obtained with P-containing rations, but supplements of P, given in the form of neutral solutions of K phosphates to a low P ration, reduced citrate elimination. An increase in urinary pH induced by vitamin D with rats on low P rachitogenic rations was not obtained with rations adequate in P, yet an increase in citrate elimination resulted in all instances. Inasmuch as a supplement of vitamin D increased urinary citrate far more than did an additional large intake of NaHCO_3 , it appears that the effect of vitamin D is due to an increase in citrate synthesis rather than to a decrease in its destruction." (Author's summary.)

586. BERG, L. R., BEARSE, G. E., and MILLER, V. L. The effect of periodically increasing the level of calcium and/or vitamin D on the performance of laying pullets. Poultry Sci. 30: 799-804. 1951.

"Periodically increasing the level of Ca and (or) vitamin D from 2.25% to 3% and from 450 AOAC chick units to 900 chick units per lb. of feed, resp., did not affect egg production, egg wt., or prevent the seasonal decline in thickness and smoothness of egg shells." (Chem. Abs. 46: 5681.)

587. BOROVSKII, E. V. Phosphorus and calcium metabolism in solid parts of tooth in dogs with experimental B_1 -avitaminosis. Stomatologiya 6: 16-20. 1955.

"Experiments on dogs showed that radioactive phosphorus and strontium injected subcut. were incorporated and eliminated more rapidly in the teeth in B_1 -avitaminosis than in the normal condition." [Russian.] (Internatl. Abs. Biol. Sci. 7: 3205.)

588. CARLSSON, A., and others. Effect of vitamin D on the citric acid metabolism. Acta Physiol. Scand. 31: 317-333. 1954.

G. Hollunger, M. Lindquist, and T. Magnusson, joint authors.

"Procedure for citric acid: ext. tissue over night with 3 ml. 30% trichloroacetic acid (TCA); transfer an aliquot to a 50-ml. glass-stoppered tube, dil. with H_2O to 10 ml., and mix with 3 ml. 18N H_2SO_4 ; add 0.5 ml. N KBr, 1 ml. N KMnO_4 , and after 10-15 min., about 0.5 ml. N KBr; after the last traces of MnO_2 disappear, add 2 ml. satd. soln. of *m*-hydroxybenzoic acid. Add 13 ml. heptane, shake vigorously and transfer an aliquot of heptane layer to a second glass-stoppered tube contg. 3.5% of 1.5% Na_2S in a mixt. of 8 vols. ethylene glycol and 2 vols. H_2O . Transfer the bottom layer to a centrifuge tube, and, after centrifuging, read the color at 450 μ in a spectrophotometer against a blank. Administration of vitamin D to young rats causes a rapid increase in the citric acid contents of serum, bones, and incisors. In serum the citric acid rises more promptly than in the bones, and is preceded by a drop. The variations in serum citric acid after feeding vitamin D were paralleled by changes in the

levels of serum Ca and (or) P, depending partly on the Ca and P contents of the diet. Marked changes in serum P (or in Ca X P) caused by varying the dietary intake of P did not affect the serum citric acid. The evidence seems to be against the assumption that the effect of vitamin D on citric acid metabolism is secondary to its action on mineral metabolism. By accelerating the production of citric acid in the bones, the solvent action of the vitamin on bone salts is thought to find its explanation." (Chem. Abs. 49: 1163.)

589. CARLSSON, A., and others. A comparative study on the mode of action of dihydrotachysterol and vitamin D on Ca metabolism. *Acta Paediatrica* 44: 548-558. 1955.

M. Lindquist, J. Liljekvist, and K. Rosengren, joint authors.

"In expts. on rats dihydrotachysterol (I) differed markedly from vitamin D in 2 respects: (1) the dose required to cure rickets was higher and (2) the therapeutic range was narrower. Earlier claims that (I) differs from vitamin D₂ in having a stronger bone-salt mobilizing effect relative to the action on Ca absorption could not be confirmed. The belief that (I) is preferable to vitamin D in hypoparathyroidism of other hypocalcemic conditions appears unfounded." (Chem. Abs. 50: 5109.)

590. CARLSSON, A., LINDQUIST, M., and MAGNUSSON, T. Cause of hypophosphatemia and hypocalcemia in vitamin D deficiency. *Acta Physiol. Scand.* 31: 308-311. 1954.

"The decrease in product Ca X P of the serum which is a distinctive finding in vitamin D deficiency is generally attributed to poor absorption of the elements from the intestinal tract. However, vitamin D produced the usual effects on the serum P level and on the skeletal uptake of P³² even in animals on a P-free diet. It is concluded that the hypophosphatemia and hypocalcemia in vitamin D deficiency is caused principally by an insufficient utilization of stored bone salt." (Chem. Abs. 49: 1163.)

591. CARLSSON, A., LINDQUIST, M., and MAGNUSSON, T. Effect of vitamin D on the absorption of inorganic phosphate. *Acta Physiol. Scand.* 31: 301-307. 1954.

"Inorg. phosphate with varying amts. of Ca was administered orally to rats deficient in vitamin D and to rats treated with the vitamin. P³² was used to study the absorption. Vitamin D increased the absorption of phosphate in Ca-deficient rats, the effect probably being an indirect one resulting from improvement in general condition. But on a diet with a high Ca/P ratio, vitamin D does not affect the absorption of phosphate. In both instances the absorption of Ca is improved by the administration of vitamin D." (Chem. Abs. 49: 1163.)

592. CARLSSON, A., LINDQUIST, M., and MAGNUSSON, T. Influence of vitamin D on the uptake of sulfur 35-labeled sulfate in the bones. *Acta Physiol. Scand.* 31: 312-316. 1954.

"It was found that the incorporation of S³⁵ into cartilage requires the presence of enzymes. Vitamin D has no direct action on the uptake of S³⁵ in bones, its action being related to the stimulating effect on growth generally. Similar effects on the uptake of S³⁵ in the bones can be produced by any means which stimulates growth as well as by vitamin D, and where there is no increase in the rate of growth of the animals, the uptake of S³⁵ in the bones is unaffected." (Chem. Abs. 49: 1163.)

593. CHIN, S., and RYO, K. Histochemical study of vitamin D. *Vitamins [Kyoto]* 12: 291-295. 1957.

"Under the microscope vitamins D (I), A₁, A₂, and carotene showed their respective fluorescences and these fluorescences had different resistance against irradiation by ultraviolet and, further, these vitamins reacted differently with SbCl₃, glycerol, dichlorohydrin, and H₂SO₄. Therefore, by the utilization of these facts, the histochemical observation of I can be achieved. By this method, I

was found as yellow granules in the cytoplasm of the cells. Its distribution in the digestive canal, liver, lungs, spleen, adrenal glands, kidneys, etc. were studied, and the authors concluded that I is mainly absorbed from the jejunum and ileum, stored in the liver, adipose tissues, adrenal glands, lungs, spleen, bones, etc. and excreted chiefly from the small intestine and kidney." (Chem. Abs. 51: 18166.)

594. CHITRE, R. G., and others. Calcium, phosphorus, and alkaline phosphatase levels in the serum of rachitic children. *Indian Jour. Med. Sci.* 8: 847-850. 1954.

P. G. Tikekar, M. K. Kelkar, and J. C. Patel, joint authors.

"Out of 600 children attending a hospital 38 were found to be suffering from rickets. Of these 19 were about a year old and two over 8 years old. The serum Ca content of the rachitic children varied from 7.6 mg. to 13.4 mg. and serum P varied from 2.1 mg. to 10.2 mg. per 100 cc. Serum alk. phosphatase activity of 20.2-56.0 Bodansky units per 100 cc. was observed in the rachitic children." (Chem. Abs. 49: 5659.)

595. CLAASSEN, V., and WÖSTMANN, B. S. J. Uptake of injected radioactive phosphorus in the skeleton of the growing white rat. II. The effect of calciferol on the rapid uptake of P³² by rachitic and control animals. *Biochim. et Biophys. Acta* 12: 577-583. 1953.

"The uptake of P³² in the femur was detd. 5 and 60 min. after intravenous injection of radioactive phosphate into rachitic and control rats, with and without the administration of 3000 international units of calciferol (I) 72 hrs. prior to injection (in some tests, 5 hrs.). In the control group, the administration of I 72 hours prior to injection of P³² did not influence the uptake of P³². In the rachitic group, however, this administration of I resulted in a greatly increased uptake of P³² when measured after 60 min., though not when measured after 5 min. I given 5 hrs. before the expt. had no effect. It is concluded that the first rapid uptake of P by exchange was not affected appreciably by the administration of I or by the restoration of plasma phosphate levels to normal on the administration of I. The restoration of the plasma phosphate levels to normal, however, was accompanied by an abnormally high skeletal accretion of phosphate in rachitic animals for some time." (Chem. Abs. 48: 4653.)

596. CLAASSEN, V., and WÖSTMANN, B. S. J. Uptake of injected radioactive phosphorus in the skeleton of the growing white rat. III. Metabolism of skeletal P³² in experiments of longer duration, performed with rachitic and control animals. *Biochim. et Biophys. Acta* 13: 48-53. 1954.

"P³² was injected into rachitic and normal rats. The P and P³² of the tibiae of the rats were detd. after 3 and 17 days, and the specific activity of the plasma inorg. phosphate was followed during the exptl. period. A substantial accretion of phosphate occurred in the tibiae of the control animals, and a small, but definite, gain occurred in the rachitic animals. The P³² increase, however, was only small, and much less than could be expected on the basis of skeletal accretion alone. It is concluded that in both groups a large loss of P³² from the skeleton occurred during the exptl. period, caused by exchange between inactive plasma inorg. phosphate and bone P³²O₄³⁻. This loss counterbalanced the effect of skeletal accretion and resulted in an apparently const. level of P³² in the skeleton." (Chem. Abs. 48: 5315.)

597. COLOVOS, N. F., and others. The effect of vitamin D on the utilization of energy and protein of the ration of calves. *Jour. Dairy Sci.* 34: 735-742. 1951.

H. A. Keener, A. E. Teeri, and H. A. Davis, joint authors.

"Both the digestion of the feed protein and retention of the absorbed nitrogen were lowered by vitamin D deficiency. The digestibility of ash likewise was affected adversely by a lack of vitamin D, but the digestion of dry matter, ether extract, fiber, nitrogen-free extract, and

energy were not affected significantly. The efficiency of energy and protein utilization was significantly decreased. The basal metabolic rate was increased in the calves as a result of vitamin D deficiency. Blood Ca and inorganic P were lowered by the deficiency, while the alkaline phosphatase activity was increased. The deficiency slowed gains in body weight and produced the usual symptoms of rickets, such as arched back, large knees, and soreness of joints. It was found that vitamin D is needed by calves not only to promote normal bone growth but also to permit efficient digestion and utilization of certain feed nutrients and a normal metabolic rate." (Author's summary.)

598. CONRAD, H. R., and HANSARD, S. L. Effects of massive doses of vitamin D on physiological behavior of calcium in cattle. *Jour. Appl. Physiol.* 10: 98-102. 1957.

"Five million units of vitamin D were administered daily for 5 days to 6 Hereford calves; changes in Ca metabolism under the influence of the large doses of vitamin D were detd. by using tracer doses of Ca^{45} as markers. Four calves receiving normal amts. of vitamin D served as controls. The true digestibility of Ca increased from an av. of 47.7% to an av. of 69.8%, denoting increased absorption. Fecal excretion of endogenous Ca decreased from 2.27 g. Ca/day to 1.64 g. daily. The calcemic effect observed in mature parturient cattle given massive doses of vitamin D was not seen in the 6-month-old calves used. Ca^{45} given either orally or intravenously disappeared more rapidly from the blood of the calves given vitamin D than from the blood of control animals. Ca retention increased approx. 3-fold in calves given vitamin D. Increased deposition of Ca^{45} was demonstrated in areas of new bone growth by specific-activity measurements and by autoradiography. Feeding of vitamin D for 2 addnl. 5-day periods apparently was without deleterious effect on Ca metabolism. Ca concns. in the kidney and esophagus increased at first, but reverted to normal after 8 days of vitamin D feeding. Autoradiographs of femur secretions indicated that deposited Ca^{45} in areas of new bone growth was exchanged more rapidly under conditions of extended vitamin D feeding." (Chem. Abs. 51: 12260.)

599. COPP, D. H., and GREENBERG, D. M. Studies on bone fracture healing. I. Effect of vitamins A and D. *Jour. Nutr.* 29: 261-267. 1945.

"A method for studying healing in standard fractures of the rat fibula is described, in which calcification activity is detd. by measuring the uptake of Sr (labeled by the presence of its radioactive isotope) by the callus, and functional recovery by the increase in breaking strength of the fractured bone. In normal rats the most active calcification of the callus occurred over the period from 8 to 16 days. The broken bone attained a strength comparable to that of the normal bone on the opposite side within 12 to 16 days. In vitamin A-deficient rats the callus was smaller than in normal rats, and the calcification was less active. The strength of the fractured bone of rats fed large doses of vitamin A was comparable to that of normal rats. On the other hand, the untreated animals showed a significant delay in fracture healing. In rachitic rats there was no significant calcification of the callus, unless vitamin D was added to the diet. In animals receiving toxic doses of vitamin D, the callus was small, calcification activity was reduced, and recovery in strength was delayed." (Chem. Abs. 39: 3043.)

600. CRAMER, J. W., PORRATA-DORIA, E. I., and STEENBOCK, H. Effect of growth hormone and vitamin D on rats on a low-Ca normal-P diet. *Fed. Proc.* 15: 547. 1956.

"A study was made of the comparative effects of growth hormone and vitamin D on growth and calcification in rats on a vitamin D-free, semisynthetic, low-Ca (0.02 percent), normal-P (0.3 percent) diet. Groups of young male albino rats weighing 80 g. were used. One group was given only the basal diet; a second group was given the basal diet plus vitamin D; and a third group was given the basal

diet plus growth hormone and no vitamin D. Ca and P balances were obtained from the 4th through the 15th day of the experiment. Bone ash, serum Ca, serum inorganic P, and metaphyseal widths were obtained at the termination of the experiment on the 15th day. It was found that both growth hormone and vitamin D produced increases in body weight, femur lengths, femur organic content, and metaphyseal widths. The increase in body weight with growth hormone, however, was only 40 percent of that produced by vitamin D. Although P balances generally reflected the relative increases in growth, the Ca losses, which were decreased by vitamin D, were not affected by growth hormone. Only vitamin D increased the absorption of the small quantities of Ca in the diet. And only vitamin D increased serum Ca and serum inorganic P. Since both vitamin D and growth hormone had an effect on growth and therefore on N and P metabolism, a growth-hormone effect on Ca metabolism was not demonstrated with our technique." (Author's abstract.)

601. CRAMER, J. W., PORRATA-DORIA, E. I., and STEENBOCK, H. Growth hormone and vitamin D in relation to growth and calcification on a calcium-deficient diet. *Endocrinology* 61: 590-593. 1957.

"Rats on a low-Ca diet responded to vitamin D by increasing body wt., org. bone wt., and femur length. Growth hormone (STH) gave 40% of the body-wt. increase induced by vitamin D. STH and vitamin D together had no additive effect on growth. STH caused a 3-fold increase in P retention, vitamin D a 5-fold increase; there was little additive effect. Only vitamin D was effective in reducing the loss of body Ca from rats on low-Ca diets. Vitamin D raised serum Ca and inorg. P, but STH had no such effect. In hypophysectomized rats on a low-Ca diet vitamin D failed to induce growth or calcification although it did increase serum Ca." (Chem. Abs. 52: 4777.)

602. CRAMER, J. W., and STEENBOCK, H. Calcium metabolism and growth in the rat on a low-phosphorus diet as affected by vitamin D and increases in calcium intake. *Arch. Biochem. and Biophys.* 63: 9-13. 1956.

"Studies with young rats on low-P, vitamin D-contg. diets, with various levels of CaCO_3 as the source of Ca, revealed that the neg. Ca balance induced by a low-P diet can be changed to a pos. one by increasing the Ca intake. This reversal was not possible when the diet did not contain vitamin D. With the afore-mentioned retention of Ca, growth decreased while the blood Ca and the amt. and percentage of ash in the bone increased. This improvement in calcification supports the theory that the decrease in growth induced by the addn. of vitamin D to this ration was effected by a differential shunting of P from the metabolic pool to bone instead of to soft tissues. Analysis of the urines revealed a definite limitation in the capacity of the kidneys to excrete Ca; this capacity was not affected by vitamin D. Ca in the feces was reduced by vitamin D at all levels of Ca intake." (Chem. Abs. 50: 14903.)

603. CRAWFORD, J. D., and others. The influence of vitamin D on parathyroid activity and the metabolism of calcium and citrate during calcium deprivation. *Endocrinology* 61: 59-71. 1957.

D. Gribetz, W. C. Diner, P. Hurst, and B. Castleman, joint authors.

"Young rats on a high-phosphate diet deficient in Ca and vitamin D developed mild tetany, parathyroid hypertrophy, lower total and ionized serum calcium concns., and rachitic bone lesions with decalcification most marked at the epiphyses. Vitamin D (10,000 I.U./day) in the above diet brought on rapidly a severe convulsive type of tetany without parathyroid hypertrophy, serum calcium levels were not altered, and there were accumulations of citrate in muscle, bone, and kidney but not brain. The bone exhibited diffuse, osteoporotic decalcification. Parathyroidectomized rats on the vitamin D-deficient diet died of hypocalcemic hyperphosphatemic tetany in 72 hrs., whereas the presence of the parathyroids enabled rats to survive longer on this diet; this suggests that vitamin D

alone can mobilize parathormone and the two act synergistically. In the expts. values were obtained for: serum Ca, inorg. P, alk. phosphatase, total P, citrate, pH, CO₂, Na, Cl, K, Mg; carcass Ca and Mg; change in carcass Ca, and ratio of epiphysis Ca to diaphysis Ca." (Chem. Abs. 51: 16762.)

604. CRUICKSHANK, E. M., KODICEK, E., and ARMITAGE, P. Vitamin D content of tissues of rats given ergocalciferol. *Biochem. Jour.* 58: 172-175. 1954.

"The distribution of vitamin D has been detd. in certain tissues of the rat 1 and 2 days following a massive oral dose of ergocalciferol (1 mg. = 40,000 I.U.). Muscle and skin together accounted for 20% on the first and for 40% on the second day, but the concn. was only 22-34 I.U. per g. The total vitamin content of the kidneys was about 220 and 180 I.U. on the 2 respective days (270 and 220 I.U. per g., resp.). In the lungs, spleen, and adrenals the concn. was about 100 I.U. per g., contributing little to the total content." (Chem. Abs. 49: 1163.)

605. DE LUCA, H. F., and STEENBOCK, H. Vitamin D and plasma phosphatase in the rat. *Jour. Biol. Chem.* 222: 937-944. 1956.

"The alkaline phosphatase content of plasma in rats on various semisynthetic, vitamin D-free rations, whether they produced approximately normal, severely rachitic, or porotic bone, was always higher than it was in rats that were fed a vitamin D-containing stock ration. The highest values were obtained with a high P, low Ca osteoporogenic ration. The administration of vitamin D prophylactically or therapeutically reduced the values to approximately those found in stock rats. The amount of phosphatase in the plasma could not be related to the severity of rickets or to the amount of cartilage present in bone." (Author's summary.)

606. DE LUCA, H. F., and STEENBOCK, H. An *in vitro* effect of vitamin D on citrate oxidation by kidney mitochondria. *Science* 126: 258. 1957.

"The comparative effect of vitamin D on the oxidation of various substrates showed that vitamin D had a pronounced effect on citrate and isocitrate oxidation. Its effect on glutamate oxidation was small, but significant, whereas on the oxidation of α -ketoglutarate, succinate, β -hydroxybutyrate, and pyruvate in the presence of oxalacetate, it had little or no effect." (Author's summary.)

607. DIKSHIT, P. K., JOSHI, J. G., and PATWARDHAN, V. N. Mode of action of vitamin D. The influence of vitamin D on the citric acid content and citrogenase activity of rachitic epiphyseal cartilage of albino rat. *Indian Jour. Med. Res.* 44: 719-725. 1956.

"The citric acid content of rat epiphyseal cartilage is lowered in rickets. Administration of a single dose of vitamin D (4,000 I.U.) caused an increase in the cartilage citrate in two phases. The initial increase took place in 24 hours after vitamin D administration and a further increase occurred after 120 hours. The citrogenase activity of the rachitic cartilage increased more than 100 percent even within 24 hours after vitamin D treatment." (Author's summary.)

608. DIKSHIT, P. K., and PATWARDHAN, V. N. Studies in experimental rickets: The alkaline serum phosphatase in rachitic albino rats. *Indian Jour. Med. Res.* 35: 91-99. 1947.

"Experiments were carried out on healthy young albino rats to determine the correlation between the intensity of rickets and the serum alkaline phosphatase activity. The animals were divided into four groups and fed for 3 weeks on diets having Ca:P ratio 1.4, 5.7, 10.2, and 15.0 to 1, respectively. Each animal was bled once a week for 3 weeks and the alkaline phosphatase was determined in the serum. The initial serum alkaline phosphatase values were quite high, but at the end of the first week on rachitogenic diets, a considerable decrease in the values was noticed in all the rats. At the end of the second week, however, a slight rise in the phosphatase value occurred

in more than half the number of animals, but at the conclusion of the experiment the phosphatase activity again markedly decreased in all the animals. At the end of 3 weeks all animals were killed. The tibiae, slit longitudinally and stained by von Kossa's method, were examined. It was observed that the epiphyseal cartilages of the rats receiving a diet with Ca:P ratio of 1.4 were normal in appearance, but with an increase in the dietary Ca:P ratio the epiphyseal cartilage disk became considerably wider and more irregular. The epiphyses of rats on the diet with a Ca:P ratio of 5.7 were appreciably wide and irregular. With the Ca:P ratio of 10.2 the cartilage had still further widened. No difference in the width of the cartilages of rats on diets with Ca:P=10.2 and 15.0 was observed. The average values of ash in the dry and fat-free femurs of the four groups were 46.12, 31.63, 28.85, and 29.20 percent, respectively. As no increase in the serum alkaline phosphatase was observed in spite of a severe rachitic condition as shown by (a) the increased epiphyseal cartilage width and (b) decreased bone-ash content, it is suggested that in rickets the serum alkaline phosphatase may not necessarily originate from the bone. The fact that other observers have found lack of correlation between serum alkaline phosphatase and severity of rickets in children and in dogs lends support to this view." (Author's summary.)

609. DOLFINI, G., and ROBUSCHI, L. Irradiated ergosterol and strontium. *Biochim. e Terapia Sper.* 18: 218-241. 1931.

Simultaneous administration of irradiated ergosterol and strontium lactate has no visible effect in young guinea pigs. In growing chickens, histological and chemical changes in bones are far more serious than when strontium alone is given. Irradiated ergosterol alone has a favorable effect on ossification, but it favors deposition of strontium the same as calcium.

610. DZIEWIATKOWSKI, D. D. Vitamin D and endochondral ossification in the rat as indicated by the use of sulfur-35 and phosphorus-32. *Jour. Expt. Med.* 100: 25-32. 1954.

"This study was undertaken to gain information about endochondral ossification in vit. D deficient rats by means of S³⁵ and P³². An attempt was made to answer the question as to whether the excess accumulation in vit. D deficient rats of apparently mature cartilage cells is a result of impaired calcification or whether the calcification is impaired by a defect in the cartilage. The experimental results detailed in the paper suggest that there is a primary defect in the cartilage, namely, an impaired utilization of chondroitin sulphate (I) for the subsequent process of calcification. The action of vit. D in vit. D deficient animals in altering S³⁵ uptake immediately but not P³² (that is until 48 hr. later) is taken as evidence to indicate that the primary action of vit. D is not in the calcification process but in S metabolism. The decrease in specific activity of I for several hours after the vit. D was administered was taken to indicate the increased utilization of the mucopolysaccharide brought about by the vit. D administration." (Excerpta Med. 8: 2644.)

611. ELLIOTT, J. R., and FREEMAN, S. Relative effect of vitamin D and parathyroid extract on plasma calcium and citric acid of normal and parathyroidectomized dogs. *Endocrinology* 59: 196-200. 1956.

"Fasting serum values of 15 mg.% Ca and 10-11 mg.% citrate are produced in normal or thyroparathyroidectomized dogs by vitamin D. Parathyroid ext. causes a similar high Ca level, but citrate levels are 7.5-8 mg.%; this effect is greatest in thyroparathyroidectomized dogs given parathyroid ext." (Chem. Abs. 51: 566.)

612. ENGFELDT, B., and HAMMARLUND-ESSLER, E. Studies on mineralized dental tissues. X. Microradiographic, autoradiographic, and histochemical investigation on dental hard tissues in dogs with experimentally produced vitamin D deficiency. *Acta Odontol. Scand.* 14: 293-311. 1957.

"The microradiograms showed that in dentine the degree of mineralization was not less at the end of the experiment than at the beginning but in the enamel defects and disturbances occurred. In the dentine in deficiency, however, the Ca^{45} zone was wider in the predentine-dentine border; the predentine was wider and so was the S^{35} uptake zone. S^{35} uptake was noted in the interglobular spaces and acid mucopolysaccharides may occur here and in the predentine." (Internatl. Abs. Biol. Sci. 7: 3204.)

613. ENGFELDT, B., and ZETTERSTROM, R. Uptake of radioactive phosphate in the skeleton of rachitic rats. *Acta Physiol. Scand.* 32: 320-324. 1954.

"Rachitic and normal rats were injected with P^{32} and killed at intervals up to 6 hrs. The relative specific activity of the different fractions of bone salts was detd. The isotope in the rapidly labeled fraction (sol. in satd. $(\text{NH}_4)_2\text{SO}_4$) was the same in both types of animals. In the slower uptake fraction (residue from $(\text{NH}_4)_2\text{SO}_4$ treatment sol. in 15% Cl_3CCOOH) the activity was much less in the rachitic animals than in the normal." (Chem. Abs. 49: 5645.)

614. FORAN, R. F., SCOTT, K. G., and PICKERING, D. E. Chemical growth dynamics of the skeleton in the immature rat. II. Effects of vitamin D deficiency. *Amer. Jour. Dis. Children* 92: 284-291. 1956.

"The effects of a vitamin D-deficient diet on the dynamics of chem. growth and compn. of the skeleton (from 21 to 75 days of age) were studied in male rats by serial analyses of the total skeleton and long-bone aliquots and Ca^{45} recoveries. Since a sizable Mg deficit developed, with only minor losses from bone, it is implied the deficit occurred in skeletal muscle. A 16% Ca deficit developed in the deficient animals by 75 days. At 21, 45, and 75 days of age a significantly greater loss of total skeletal Ca^{45} occurred in the deficient animals than in the controls. The parallel nature of losses of skeletal Ca and Ca^{45} indicates that they originated primarily from bone during turnover. Chem. compn. of long bone did vary significantly from normal and, therefore, did not reflect the over-all skeletal losses." (Chem. Abs. 50: 17079.)

615. FRICSAY, M. Polarized light and histological studies of the decalcified bone tissue of rachitic rats during therapy with vitamin D_3 . *Schweiz. Ztschr. f. Allg. Path. u. Bakt.* 20: 85-89. 1957.

"The affinity of bone tissue for dyes was detd. during the recovery of rachitic rats fed vitamin D_3 . The healing with vitamin D was not only in the calcification zone but also in the bone matrix. The ground substance (protein) of the bone tissue showed an increased affinity for azocarmine which reached a max. on the 7th day of therapy. Thus, protein as well as Ca and phosphate metabolism has an important role in the development and therapy of rickets." (Chem. Abs. 51: 8946.)

616. GERSHOFF, S. N., and HEGSTED, D. M. Effect of vitamin D and calcium:phosphorus ratios on chick gastrointestinal tract. *Amer. Jour. Physiol.* 187: 203-206. 1956.

"The effect of feeding diets contg. various Ca:P ratios (4:1, 1:1, 1:2) to rachitic chicks was studied. The Ca:P ratios used had no significant effect on Ca absorption in chicks receiving vitamin D but were of importance in the Ca absorption of rachitic chicks. Vitamin D increased Ca absorption in chick duodenum but had no effect on glucose absorption. Increased peristalsis was obtained when vitamin D or the least rachitogenic Ca:P ratio (1:1) was fed. A possible increase in intestinal mucosa respiration was also observed when vitamin D or the 1:1 Ca:P ratio was fed." (Chem. Abs. 51: 4520.)

617. GERSHOFF, S. N., and HEGSTED, D. M. Effect of vitamin D-deficient diets containing various Ca:P ratios on cats. *Fed. Proc.* 15: 552-553. 1956.

"Four groups of kittens were maintained for more than a year and a half on purified diets with and without vitamin

D and containing either 1 percent of Ca and 1 percent of P or 2 percent of Ca and 0.7 percent of P. Rickets produced by diets with the 1:1 Ca:P ratio was much more severe than that produced by the high Ca:P ratio as judged by X-ray, serum alkaline phosphatase, and longevity data. Serum Ca, P, protein, and citric acid and urinary Ca, P, N, and citric acid values were obtained. After about a year on the experimental diets a marked spontaneous improvement was observed in the condition of all but one of the rachitic cats. This probably indicates a very low vitamin D requirement in cats 2 years or older. Alterations in the experimental diets obtained by changing their Ca but not their P levels to produce 0.5:1, 1:1, 2:1, and 3:1 Ca:P ratios did not result in significant changes in urinary Ca but produced approximately tenfold increases in urinary P as the Ca:P ratio was lowered from 3:1 to 0.5:1. There were no significant differences in the urinary Ca and P excretion of cats receiving and not receiving vitamin D." (Author's abstract.)

618. GILLMAN, J., and GILBERT, C. Calcium, phosphorus, and vitamin D as factors regulating the integrity of the cardiovascular system. *Expt. Med. and Surg.* 14: 136-168. 1956.

"Oral administration of recrystd., highly purified calciferol (vitamin D_2) in destearinated peanut oil in doses up to 25,000 units 5 times at daily intervals, to male and female rats aged 3-6 months, caused cardiovascular reactions ranging from calcification, at one extreme, to subendothelial edema and small cellular vegetations on the endothelium of the aorta, in the ostia of the coronary arteries, and on the valves, at the other extreme. Extensive necrotizing arteritis sometimes supervened without histol. evidence of calcification. The gravity of the cardiovascular lesions appeared to depend on, or be complicated by, impairment of kidney function. Arterial lesions induced by the vitamin were linked with those known to follow severe kidney disease induced by other techniques. Importance was attached to the role of vitamin D, Ca, and P as one link in a complicated mechanism responsible for regulating the structural integrity of the cardiovascular system. The lower incidence of cardiovascular disease occurring among Africans, as compared with persons of European origin in South Africa, may be attributable in part to fundamental differences in Ca and P metabolism determined by diet. 81 references." (Chem. Abs. 51: 6796.)

619. GRAINGER, R. B., O'DELL, B. L., and HOGAN, A. G. Congenital malformations as related to deficiencies of riboflavin and vitamin B_{12} , source of protein, calcium to phosphorus ratio, and skeletal phosphorus metabolism. *Jour. Nutr.* 54: 33-48. 1954.

"It appears that a deficiency of either vitamin B_{12} or riboflavin in rats results in defective cartilage formation and a lower phosphatase activity. Consequently there is a decreased rate of ossification in the skeletal tissue. A high Ca:P ratio also increased skeletal defects." (Chem. Abs. 49: 2577.)

620. GREENBERG, D. M. Studies in mineral metabolism with the aid of artificial radioactive isotopes. VIII. Tracer experiments with radioactive calcium and strontium on the mechanism of vitamin D action in rachitic rats. *Jour. Biol. Chem.* 157: 99-104. 1945.

"The deposition of radioactive Ca and Sr in various tissues of young, treated, or untreated rachitic rats was investigated. Paired groups of rats received ergosterol (10,000 U.S.P. XI units of vitamin D per g.) or cottonseed oil orally 72 hrs. and 1 hr. prior to the administration, by stomach tube or by intraperitoneal injection, of the lactates of radioactive Sr (0.5 to 2 mg.) and Ca (1.5 to 4 mg.). The excreta (including the unabsorbed contents of the intestines) and the skeleton contained the bulk of the 2 elements; only negligible amts. were found in the soft tissues. The data indicate that vitamin D promotes the absorption of Ca from the intestinal tract but not that of Sr. From 60 to 70% of the Ca and Sr administered orally to the rachitic animal was excreted in the feces in 3 days,

20% in the urine. In the vitamin D-treated rat 15% of the Ca and 30% of both were lost in the urine. The bones of the untreated rats took up 10% Sr and 15% Ca, those of treated animals 15% and 30%, respectively. Little extra Sr or Ca were deposited in the teeth of the treated rats. Data similar to the above are presented for rats treated by injecting the radioactive elements." (Chem. Abs. 39: 2112.)

621. GUNTHER, L., and others. Metabolism of bone salts in resistant rickets. Report of a case, with balance and radioactive tracer studies. *Amer. Jour. Dis. Children* 66: 517-527. 1943.

E. T. Cohn, W. E. Cohn, and D. M. Greenberg, joint authors.

"In a case of rickets which persisted for 14 yrs. in spite of treatment with vitamin D and supplements of Ca salts, the primary defect appeared to lie in a failure of the calcifying mechanism. During the course of the disease pos. Ca and P balances could be maintained only when the intake of these elements was high. Changes in the balances corresponded to changes in the amts. of Ca and P excreted in the feces. The urinary excretion remained practically unchanged with either high- or low-Ca diets. Tracer expts. (P_{32} given as Na_2HPO_4) showed that phosphate was readily absorbed from the intestinal tract. The disorder was finally corrected by daily administration of fish-liver oil of high vitamin D content." (Chem. Abs. 38: 2706.)

622. HAAVALDSEN, R., EGNUND, K. M., and NICOLAYSEN, R. Studies in calcium metabolism in rats. II. The interaction of vitamin D and the endogenous factor. *Acta Physiol. Scand.* 36: 108-113. 1956.

"The absorption of Ca is subject to regulation by vitamin D and unknown endogenous factors. Vitamin D appears to be the primary regulating factor, without which the endogenous factors cannot develop their action." (Chem. Abs. 50: 14899.)

623. HAAVALDSEN, R., and NICOLAYSEN, R. Studies in calcium metabolism in rats. I. A long term study in rats given an optimal diet with and without vitamin D. *Acta Physiol. Scand.* 36: 102-107. 1956.

"Vitamin D influenced Ca absorption only in the first 21 weeks of life. Its administration resulted in heavier animals with more densely mineralized bones, contg. less water and matrix than bones in vitamin D free rats of the same age. These animals were observed for 18 months." (Chem. Abs. 50: 14899.)

624. HANSSLER, H. Influence of the adrenal cortex on the bone growth of rats on vitamin-D-free diet. *Klin. Wchnschr.* 34: 646-647. 1956.

"Cortisone is of physiological significance in normal bone growth, particularly in ossification of the epiphyses. The effect is seen particularly in animals on vitamin-D-free diet. Cortisone (0.5 to 2.5 mg. daily) leads to involution of the spleen and thymus and in rachitic animals causes a decrease in the serum inorg. P but the serum Ca level remains unchanged." [German.] (*Internat. Abs. Biol. Sci.* 5: 1865.)

625. HARRISON, H. E. Mechanism of action of vitamin D. *Pediatrics* 14: 285-295. 1954.

"A study of the mechanisms of the action of vitamin D based on the different clinical dosage requirements. Two aspects of vitamin D effect, one involving renal tubular functions and the other the metabolism of citrate are discussed and a relationship between them was developed. The citrate metabolism appears to be the common denominator which links the renal tubular function concerned with regulation of the pH of urine and body fluids and those which control renal tubular reabsorptions of phosphate and the phosphate concns. of the body fluids. Two forms of renal tubular dysfunction have been produced experimentally with metabolic inhibitors. These dysfunctions resemble in part two distinct inborn errors of renal tubule function in infants assoc. with rickets resist-

ant to vitamin D. In both these states abnormalities of the patterns of metabolism of the polycarboxylic acids of the Krebs cycle may play an important role. Further exploration of the specific function of the polycarboxylic acids in renal tubule mechanisms may not only provide a clue to the metabolic systems in which vitamin D interacts, but should also give insight into the mechanisms of renal tubular regulation of the H-ion concn." (Chem. Abs. 49: 2576.)

626. HERTING, D. C., and STEENBOCK, H. Vitamin D and gastric secretion. *Jour. Nutr.* 57: 469-482. 1955.

"The effect of vitamin D on gastric secretion was determined in a series of experiments with rats kept on natural or semisynthetic rations, normal or rachitogenic. The gastric secretion was collected after a 10- to 24-hour period of fasting followed by pyloric ligation. Vitamin D was found to increase the volume and acidity of the secretion after the feeding of rachitogenic diets. No increase in acidity was obtained with rats on a normal diet or on a diet high in P. When induced with rachitogenic diets the increase could be correlated with an increase in serum P. No effect of vitamin D was demonstrable when the preoperative fasting period was reduced to 4 hours. Analysis of the rats failed to reveal any effect of vitamin D on body hydration." (Author's summary.)

627. HIBBS, J. W., and POUNDEN, W. D. Effect of parturient paresis and the oral administration of large prepartal doses of vitamin D on blood calcium and phosphorus in dairy cattle. *N.Y. Acad. Sci. Ann.* 64: 375-385. 1956.

628. HILTIBRAN, R. C., HOECKER, F. E., and MILLS, R. C. Effect of vitamin D on retention of radium by the white rat. *Soc. Expt. Biol. and Med. Proc.* 95: 772-774. 1957.

"Total body retention of injected Ra was significantly less in rachitic rats than in vitamin D-treated rachitic rats or in nonrachitic controls." (Chem. Abs. 52: 1390.)

629. HOWARD, J. E., and CONNOR, T. B. Some experiences with the use of vitamin D in the treatment of hypoparathyroidism. *Assoc. Amer. Physicians Trans.* 67: 199-205. 1954.

"The best available drugs to combat the hypocalcemic effects of hypoparathyroidism are calciferol and dihydro-tachysterol. The renal threshold for calcium seems to be altered by these drugs when given in doses adequate to elevate the serum calcium 2-3 mg. percent in hypoparathyroid patients—i.e., at total serum calcium levels in which but little calcium would ordinarily appear in the urine, hypercalcaemia is seen. Poisoning with these substances is accompanied by an extracellular alkalosis, which deserves further study." (Author's summary.)

630. JOSHI, J. G., and DIKSHIT, P. K. Effect of vitamin D on phosphorus content of rachitic rat cartilage. *Nature* 177: 625. 1956.

631. JOSHI, J. G., DIKSHIT, P. K., and PATWARDHAN, V. N. Mode of action of vitamin D on citrogenase and citric acid in dogs in induced rickets. *Indian Jour. Med. Res.* 45: 439-445. 1957.

"Oral administration of 1 dose (100,000 I.U. per kg.) of vitamin D₂ to rachitic dogs increased the citrogenase activity, citric acid, and total P of cartilage. An increase in serum Ca, inorg. P, and citric acid was noted. No change was observed in the serum protein level." (Chem. Abs. 52: 1388.)

632. KEANE, K. W., COLLINS, R. A., and GILLIS, M. B. Isotopic tracer studies on the effect of vitamin D on calcium metabolism in the chick. *Poultry Sci.* 35: 1216-1222. 1956.

"The principle effect of vitamin D was upon the absorption of Ca from the intestinal tract. In vitamin D-deficient birds, Ca absorption from the intestine was poor

but bone deposition of injected Ca was normal. Addn. of vitamin D to the diet resulted in a rapid increase in Ca absorption." (Chem. Abs. 51: 14916.)

633. KOYANAGI, T., and ONISHI, N. Calcification in the bone of rats as influenced by vitamin D and ergosterol with rice diets. *Vitamins* [Kyoto] 9: 132-135. 1955.
"The ash content of the tibia of rats fed on either Et₂O-extd. rice or nonextd. rice was taken as a criterion for the estn. of vitamin D (I); it was concluded that the polished rice (polishing rate 90%) contained little or no I. When rats fed on nonirradiated unpolished rice were exposed to ultraviolet light, I was not produced in their bodies, while when the animals were fed on polished rice mixed with ergosterol, the vitamin was produced abundantly by irradiation." (Chem. Abs. 50: 15777.)

634. LECOQ, R., and VILLETTE, H. Phosphorus and rickets. III. Inhibiting effect upon osseous calcification in rachitic rats by certain metals added to rations in the form of carbonates or phosphates. *Jour. de Pharm. et de Chim.* 19: 201-206. 1934.

Magnesium and strontium carbonates added to a ricket-producing diet of Randoim-L increase its severity, inhibiting the activity of Na₂HPO₄ added in curative doses. Phosphates of magnesium and strontium have a manifesting calcifying action, especially in weaker doses.

635. LINDQUIST, B. Effect of vitamin D on the metabolism of radiocalcium in rachitic rats. *Acta Paediatrica* 41: 599-603; sup. 86, 82 p. 1952.

"The absorption of radioactive Ca from the digestive tract increased with increasing dose of vitamin D (I) up to a certain level beyond which further increase of the dose failed appreciably to increase absorption. The effect of a physiol. dose of I on Ca absorption was demonstrable 4-12 hrs. between the administration of I and Ca; it then gradually increased, reached a max. at 60-72 hrs., then began to diminish after 9 days, and had passed off entirely in about 16 days. The Ca values from the digestive tract and feces after parenteral administration of Ca were smaller in the I-treated rats. An effect of I on Ca absorption from the digestive tract is demonstrable 1 hr. after Ca administration. Ca absorption from the digestive tract occurs by means of 2 mechanisms, one independent, the other controlled by I. The results of the addn. of phosphate to a rachitogenic diet on Ca metabolism indicate that the favorable effect of I on Ca absorption is probably not secondary to an increased deposition of Ca salts in the skeleton. Parenteral administration of phosphate to rachitic rats increased absorption of Ca given simultaneously by mouth. This effect seen also in I-treated animals is probably of secondary nature. Investigation of the specific activity of serum Ca in I-treated and untreated rachitic rats suggests that an increased uptake of Ca in the bones on I administration represents an increased deposition of Ca salts. The response of rachitic rats to Ca administration is related to the dose of I given. The curve for the Ca uptake in the bones has the shape of a logarithmic function. This was used as the basis for a biol. assay of I. When I was given at different intervals before Ca administration the curve for the uptake of Ca in the bones showed practically the same course as that described above for the absorption. In rachitic rats the skeletal uptake of parenterally administered Ca was greater in I-treated than in untreated animals. The correlation between the inorg. P in the serum and the uptake of Ca in the femur was statistically highly significant. I administration did not increase the specific activity of the serum Ca despite an increased amt. of Ca entering the blood from the intestines. The results suggest that the effect of massive doses of I on the skeleton is at least partly an accentuation of the physiol. effect." (Chem. Abs. 49: 16097.)

636. LINDQUIST, B. The mode of action of dihydrotachysterol on calcium metabolism. *Helvet. Paediatrica Acta* 10: 131-133. 1955.

"There were no essential differences in the absorption of Ca and the metabolism of bone salts in rats given

equiv. doses of dihydrotachysterol (I) and vitamin D (II). I has an antirachitic effect as well as II. However, the therapeutic range of I was much smaller than of II." (Chem. Abs. 50: 2866.)

637. LINDQUIST, B. The mode of action of vitamin D; recent findings. *Nord. Med.* 58: 1045-1047. 1957.

638. LÖHR, H. Glucose-6-phosphatase in liver and kidneys in experimental rickets of rats and the effect of vitamin D. *Ztschr. f. Kinderheilk.* 79: 413-417. 1957.

"Of 55 rats weighing from 30 to 60 g., in 3 groups of from 15 to 20, one group received a normal diet of ground wheat and Pelargon; the other 2 groups received the rachitogenic diet 3143 of McCollum with "Leim" instead of gelatine (presumably a crude for a purified product), and one of the 2 groups received also daily 2 I.U. vitamin D₃. After 12 days half the animals were killed, and after 24 days the other half. The liver and kidneys were taken and quickly frozen. Glucose-6-phosphatase in the organs was estimated from the amount of inorganic P, measured by the method of Lowry *et al.* (*J. Biol. Chem.*, 1954, 207, 1) modified, liberated from glucose-6-phosphate.

After 12 days rachitic changes in the skeleton were not detected by X-ray, and there was no modification of the phosphatase values.

After 24 days the rats receiving the rachitogenic diet without vitamin D showed well marked rachitic changes. The mean values for phosphatase, expressed as $\mu\text{g. P}$ liberated per 100 mg. frozen tissue, were not significantly changed in the liver, but in the kidneys they were, for normal diet 653 ± 5.73 , for rachitogenic diet without vitamin D 450 ± 6.50 , and for rachitogenic diet with vitamin D 618 ± 6.61 ." (Nutr. Abs. and Rev. 27: 4805.)

639. MAROLDA, C. I. Influence of vitamin D on rectal absorption of calcium. *Rev. de la Asoc. Méd. Argentina* 68: 171-173. 1954.

"In human subjects at rest in bed a rectal suppository contg. 1 g. of Ca gluconate produced a slight rise in blood Ca which began after 3-4 hrs., reached the peak at 4-8 hrs., and then declined. A suppository contg. 0.75 g. Ca gluconate, 0.25 g. Ca ascorbate, and 5000 units vitamin D produced a rise which began at about 2 hrs. and remained up until the 16th hr. This rise was 0.5-1.0 mg. % regardless of the initial Ca level of the serum." (Chem. Abs. 49: 2612.)

640. MELLANDER, O., and OLSSON, N. The influence of peptide-bound calcium and phosphorus on bone calcification in rickets. *Bol. Méd. del Hosp. Infant. [Mexico]* 13: 243-246. 1956.

"These groups of chickens were fed with a rachitogenic ration during the 1st week after hatching. Ca, P, and a suboptimal dose of vitamin D were added to the diet of group I; a prepn. of Ca phosphopeptide in the same proportion was added to the diet of groups II and III. After 2 weeks it was observed that the bone calcification of chickens given rachitogenic diet was better than when Ca phosphopeptides were given as mineral source than when the corresponding amt. of bone meal was used." (Chem. Abs. 50: 14067.)

641. MIGICOVSKY, B. B., Influence of vitamin D on calcium resorption and accretion. *Canad. Jour. Biochem. and Physiol.* 35: 1267-1275. 1957.

"The absorption of Ca through the intestinal mucosa of the chick was shown to come under the influence of vitamin D within 2-4 hrs. after vitamin D administration. The effect of vitamin D on the rates of accretion and resorption was detd., and it was concluded that vitamin D affects the accretion rate, which in turn could bring about an increase in the resorption rate per bone. It cannot be stated whether the action of the vitamin D on the bone is direct or indirect." (Chem. Abs. 52: 4762.)

642. MIGICOVSKY, B. B., and EMSLIE, A. R. G. Deposition of radioactive calcium in rachitic and non-

rachitic chick tibia from oral and intramuscular doses of Ca^{45} . Arch. Biochem. 28: 324-328. 1950.

"Experiments on the deposition of calcium in rachitic and nonrachitic chick tibia from oral and intramuscular doses indicate that vitamin D does not exert a direct effect on the mineralization of bones of chicks." (Author's summary.)

643. MIGICOVSKY, B. B., and JAMIESON, J. W. S. Calcium absorption and vitamin D. Canad. Jour. Biochem. and Physiol. 33: 202-208. 1955.

"The rate at which Ca^{45} administered orally appears in blood and bone of chicks is markedly affected by vitamin D. Absorption of Ca^{45} from an intramuscular dose is not influenced by either vitamin D or the Ca content of the diet. The vitamin D effect on absorption of an oral dose is a function of the amt. of Ca presented for absorption. Vitamin D enables chicks to adapt the capacity to absorb Ca to different dietary Ca intakes." (Chem. Abs. 49: 7082.)

644. MIGICOVSKY, B. B., and NIELSON, A. M. Calcium absorption and vitamin D in the chick. Arch. Biochem. and Biophys. 34: 105-111. 1951.

"The amt. of Ca^{45} appearing in the tibias of chickens after an intramuscular injection of Ca^{45} was directly proportional to the amt. injected. Vitamin D slightly decreased the quantity of Ca^{45} appearing in the bone. The proportion of an oral dose of Ca^{45} which appeared in the tibia after a definite period of time was used as an estimate of the rate of absorption. This estimate of absorption is a sensitive criterion of response to vitamin D treatment. The presence of excess phosphate in the gut did not interfere with Ca absorption. Vitamin D affected the absorption of Ca within the 1st 30 min. after the administration of Ca. There is a difference in behavior between rats and chicks which is due to a difference in the metabolism of Ca, not to vitamin D action. In the rat the tubular reabsorption or urinary excretion mechanism is of greater importance than it is in the chick." (Chem. Abs. 46: 11366.)

645. MIYAZAKI, M., and SAKURAI, Y. Biological effect of vitamin D. I. Relation of vitamin D to rat growth and rickets with various calcium: phosphorus ratios in the diet. Vitamins [Kyoto] 11: 450-457. 1956.

"A dose of vitamin D (I) promoted the growth of rats fed a synthetic diet having a normal Ca/P ratio (1:1), and rickets was not observed in the rats on the same diet, even without the administration of I. When fed on Ca-high or P-low diet (Ca/P 5:1 or P=0), rats showed better growth without administration of I and a marked symptom of rickets was observed. A depression of rat growth was caused by addn. of I on a P-low diet." (Chem. Abs. 51: 14921.)

646. NAKAMURA, I. Significance of alkaline phosphatase in rickets. I. Variation of alkaline phosphatase activity of serum in rickets. Vitamins [Kyoto] 11: 458-467; Koshu Eiseiin Hokoku 6: 27. 1956, 1957.

"The alk. phosphatase (I) activity, which is one of the valuable indicators for estg. the severity of rickets (II), was detd. following the progression of II of albino rats. From the X-ray examn., it was found that there were 3 stages in II, that is, the progressing, stationary and decline. At the 1st and 3rd stages, the I activity seemed likely to be elevated; it decreased at the 2nd stage below the normal level. From these results, it is assumed that the I activity of serum is not parallel to the severity of II, but rather indicates whether the progress in II is active or not." (Chem. Abs. 51: 15721.)

647. NAKAMURA, I. Significance of alkaline phosphatase in rickets. II. Effect of vitamin D on the alkaline phosphatase activity of serum and organs. Vitamins [Kyoto] 12: 52-56. 1957.

"The prophylaxis and therapy of the rickets (II) of albino rats were studied with different dosages of vitamin D (50, 100, and 200 I.U./week *per os*). The effect of vita-

min D was estd. by alk. phosphatase (I) activities in the serum, bone, kidney, and intestine. In the prophylactic expt., the existence of a parallelism between the doses of vitamin D and the I activities in the serum and in the bone could be found, and, especially in the latter, the I activity was inversely proportional to the log of the doses of vitamin. Such a relation could not be found in therapeutic expt. In both expts., the variation of I activity of serum seemed to have no correlation with that in the kidney and intestine." (Chem. Abs. 51: 1572.)

648. NUMEROF, P., and others. The use of radio-active phosphorus in the assay of vitamin D. Jour. Nutr. 55: 13-21. 1955.

H. L. Sassaman, A. Rodgers, and A. E. Schaefer, joint authors.

"The validity of the radiophosphorus procedure for vitamin D assay reported by Snyder, Eisner, and Steenbock has been confirmed. The method has been compared against the line test in concurrent assays and has given potencies agreeing with those obtained with the U.S.P. standard line test. The radiophosphorus assay has been shown to possess several advantages over the U.S.P. "line test." The prime advantage is that the subjective nature of the line test assay is completely eliminated without any loss of accuracy. Furthermore, complications inherent in the line test, such as calcification evidenced as a diffuse accretion contiguous to the diaphysis, decreased food consumption, and insufficient weight gain, do not appear to affect the results when the radiophosphorus method is used." (Author's summary.)

649. PATRICK, H., and BACON, J. A. The effect of vitamin D upon bone mineralization of Ca^{45} and Sr^{90} as chlorides and phosphopeptides. Jour. Biol. Chem. 228: 569-572. 1957.

"The data on Ca^{45} or Sr^{90} phosphopeptide utilization indicate that the rat can utilize Ca^{45} or Sr^{90} in the form of a phosphopeptide more efficiently than the inorganic salts of these same radionuclides with or without vitamin D in either ration. The use of vitamin D, however, increases the efficiency of utilization of Ca^{45} and Sr^{90} in both the organic and inorganic forms in both rat and chick. The chick, however, cannot utilize the Ca^{45} or Sr^{90} in the phosphopeptide form in the absence of vitamin D, as efficiently as the inorganic salts in the absence of vitamin D. The nutritional importance of vitamin D as an aid in calcium and strontium usage is greater in the chick than in the rat." (Author's summary.)

650. PATRICK, H., and SCHWEITZER, G. K. A chick vitamin D assay method with radioactive calcium (calcium-45). Poultry Sci. 34: 834-835. 1955.

"A method in which Ca^{45} deposition in the tibiae provides a measure of mineralization requires less time than the bone ash method of chick vitamin D assay." (Chem. Abs. 50: 13145.)

651. PATRICK, H., and SCHWEITZER, G. K. Use of calcium-45 in determination of vitamin D depletion and response time in chicks. Poultry Sci. 34: 832-833. 1955.

" Ca^{45} was administered orally and the chicks killed 24 hrs. later, with Ca^{45} deposition in the tibiae used as a measure of bone mineralization. Chicks on a vitamin D-deficient ration are depleted by 14 days with mineralization dropping from 13.4 to 7.8%. The chick stores a single dose of vitamin D poorly, but will respond to vitamin D supplementation within 4 hrs. with normal response in 24 hrs." (Chem. Abs. 50: 13145.)

652. PERKOVICH, E. A. A study of some points on experimental rickets by the method of labeled atoms. Vest. Rentgenol. i Radiol. 31: 12-18. 1956.

"The use of P^{32} and Ca^{45} tracers in studies with rats, showed that these elements are intensively retained in the bones of rachitic rats, but that their residence in the bones is temporary. Hence, the metabolism of Ca and P in such rats is accelerated over normal animals, causing a deficiency in the mineral salts." (Chem. Abs. 50: 14947.)

653. PETUKHOVA, E. A. The vitamin-D requirements of suckling-calves. *Moskov. Vet. Akad. Trudy* 11: 35-41. 1956.

"In the study of the vitamin D requirements of calves two groups of animals were used: one consisting of 14 head was the exptl. group, another consisting of 36 head was the control group. The rations of the animals of the exptl. group were supplemented by 20-40 I.U. of the vitamin/kg. of animal body wt., which was fed to the animals 3-4 times daily for a period of 100 days. No reduction in the Ca and P content of the blood serum of the exptl. animals was observed as they grew older; in the animals of the control group a lowering in the Ca and P was observed on the 30-50th day. The author is of the opinion that vitamin-D supplement to the rations of growing calves should be regarded as a must to secure their normal growth and development." (Chem. Abs. 51: 74927.)

654. PICKERING, D. E., and others. Chemical growth dynamics of the skeleton in the immature rat. III. Correlation of growth and morphology of long bones with chemical growth in normal and vitamin D deficient animals. *Amer. Jour. Dis. Children* 92: 292-296. 1956.

L. B. Lusted, R. F. Foran, and J. T. Crane, joint authors. "Tibial growth and morphology were evaluated in immature male Wistar rats on normal and vitamin D-deficient diets and were correlated with skeletal chem. growth and turnover.

The percentage daily increment in tibial diaphyseal length was not proportional to the percentage increase in skeletal Ca from 1 to 75 days of age. While maintenance of these immature animals on a vitamin D-deficient diet induced significant chem. changes, these changes were in no way reflected by alterations in linear growth of tibiae, and were accompanied by only minor histological changes." (Chem. Abs. 50: 17079.)

655. PINCUS, J. B., GITTLEMAN, I. F., and SOBEL, A. E. Influence of vitamin D on serum calcium and inorganic phosphate in the neonatal period. *N.Y. Acad. Sci. Ann.* 64: 424-427. 1956.

"Vitamin D, when administered to infants in processed milk or in powd. milk formulas during the first week of life, increased the no. of instances of hypocalcemia and hyperphosphatemia. It is suggested that a transient state of hypoparathyroidism may exist during the first week of life, which is aggravated by the vitamin D; this causes the infants to have a greater tendency toward a lowering of serum Ca and raising of serum P concns." (Chem. Abs. 51: 9827.)

656. RAIHA, C. E., and FORSANDER, O. Vitamin D and phosphorylation of thiamine. *Acta Paediatrica* 43 (sup. 100): 541-544. 1954.

"Phosphorylation of thiamine (I) in rachitic white rats was more rapid when I and vitamin D were administered by injection or orally than when I was given alone." (Chem. Abs. 50: 5109.)

657. RUPP, W., and SWOBODA, W. Phosphate metabolism in vitamin-D resistant rickets (phosphodibetes). III. Results of hyper- and hypo-function of the parathyroid gland. *Helvet. Paediatrica Acta* 11: 256-268. 1956.

"Phosphate (I) excretion was measured under conditions of I infusion and simultaneous intravenous vitamin-D (II) injection in 3 patients with extreme situations of I metabolism. The cases included: primary hyperthyroidism from parathyroid adenoma, post-operative parathyroid insufficiency, and osteodystrophy from chronic renal insufficiency. For comparison, data are given also for a case of II-resistant rickets (case 3, described in the preceding part) and for normal patients. It is concluded that the II effect is mediated via the parathyroid, and that the high doses of II inhibit the phosphaturic effect of parathormone. Such an inhibition may result from diminution of the excretion of parathormone as well as from direct

action on the tubules. The Q_{PO_4} (serum I:I reabsorption) was considered an adequate criterion for relating the degree of parathyroid function to renal excretion. No gross disturbance of parathyroid activity was found in II-resistant rickets." (Chem. Abs. 51: 14919.)

658. SANO, T., and GOTO, T. Metabolism of various inorganic substances. I. Changes in content of inorganic salts in the excrement of rachitic animals by the injection of vitamin D₂. *Vitamins [Kyoto]* 11: 293-300. 1956.

"The injection of vitamin D₂ to healthy and experimentally induced rachitic animals caused a decrease of excretion of Ca, P, Fe, and Cu in both the healthy and rachitic animals, and in far greater degree in the latter animals. Excretion of K decreased in the healthy, whereas it increased remarkably in the rachitic animals." (Chem. Abs. 51: 18165.)

659. SAVILLE, P. D., and others. Effect of A.T. 10 on calcium and phosphorus metabolism in resistant rickets. *Clin. Sci.* 14: 489-499. 1955.

J.R. Nassim, F. H. Stevenson, L. Mulligan, and M. Carey, joint authors.

"Studies on 6 patients showed that the Ca- and P-retaining effect of A.T. 10 is similar to that of calciferol. Addition of phosphate to the diet increased this effect and lowered serum Ca." (Internatl. Abs. Biol. Sci. 5: 4901.)

660. SCHEER, K. E., and KAUTZ, G. Simultaneous determination of the radiocalcium and radiophosphorus incorporation rate in young rat bones during improving rickets. *Ztschr. f. Kinderheilk.* 78: 699-702. 1956.

661. SMITH, R. H. Calcium and magnesium metabolism in calves. Plasma levels and retention in milk-fed calves. *Biochem. Jour.* 67: 472-481. 1957.

"Calves were fed on diets consisting basically of whole milk for up to 46 weeks. At ages less than 5 weeks they were shown to retain 39-54% and to excrete in the urine 13-34% of their dietary Mg. The hypomagnesemia, which sooner or later appears as the calves got older, was shown to be assocd. with a progressive decrease in their ability to utilize dietary Mg. This decrease continued until little or no Mg was retained or excreted in the urine. Hypocalcemia, which also occurred in some of the calves when inadequate vitamin D was present in the diet, appeared to be assocd. with a decrease in their ability to utilize Mg, but the addn. of a high level of vitamin D to the diet led to a marked improvement in Ca utilization only. The amt. of vitamin D required to restore and maintain normal Ca retention appeared, in some cases, to be exceptionally high. The changes in the plasma-Mg and -Ca levels did not appear to be assocd. with any changes in the plasma inorg.-P level or in the proportions of plasma Mg and Ca which were ultrafilterable. Growth of the calves appeared to be unaffected during the early stages of Mg deficiency. It was, however, sometimes inhibited after a long period of gross hypomagnesemia." (Chem. Abs. 52: 5567.)

662. STEENBOCK, H., and BELLIN, S. A. Vitamin D and tissue citrate. *Jour. Biol. Chem.* 205: 985-991. 1953.

"The citrate content of blood, bone, kidney, heart, and the small intestine of rats on normal or low phosphorus rachitogenic rations was increased by physiological doses of vitamin D. It did not affect liver citrate. Comparable to changes in urinary citrate, tissue citrate was highest in rats kept on a low phosphorus ration, but vitamin D produced the biggest increase with phosphorus-containing rations. Vitamin D was as effective in increasing blood and bone citrate in the presence of dietary bicarbonate as in its absence, although bicarbonate itself had little or no effect. It appears that the increase in urinary citrate is a reflection of its increased accumulation in certain tissues." (Author's summary.)

663. STEENBOCK, H., and HERTING, D. C. Vitamin D and growth. *Jour. Nutr.* 57: 449-468. 1955.

"In a series of experiments with young rats, it was found that a low Ca diet adequately supplied with phosphorus and other dietary essentials presented optimum conditions for eliciting the maximum growth differential that can be obtained with vitamin D. This effect of the vitamin was accompanied by a decrease in serum inorganic P, an increase in serum Ca, a decrease in the percentage of bone ash, an increase in the organic matrix of bone, and a slight increase in the width of the cartilaginous metaphyses. Vitamin D always tended to bring the serum P to a normal level. On the other hand, its only effect on the level of serum Ca was to increase it.

It was impossible to duplicate the growth-promoting effect of vitamin D by varying the amount and proportion of P and Ca in the diet. The effect was the same whether Ca was given as the carbonate or as the chloride. Although the sole addition of Ca to a low Ca adequate P diet increased growth, such additions when given continuously or in successive increments could not raise growth to the level induced by vitamin D alone. Also, when the dietary Ca/P ratio was raised too high, i.e., to an approximate ratio of 4.5 to 1.0, vitamin D depressed growth.

The large increase in soft tissue, as well as of organic bone, when vitamin D is given, suggests that it facilitates other reactions than those concerned with the intestinal absorption and the skeletal deposition of mineral elements. It appears that the weanling rat requires vitamin D for optimum performance." (Author's summary.)

664. STEENBOCK, H., and others. Vitamin D and intestinal phytase. *Jour. Biol. Chem.* 205: 993-999. 1953.

C. H. Krieger, W. G. Wiest, and V. J. Pileggi, joint authors.

"Supplements of vitamin D tended to increase the extractable intestinal phytase of rats and chicks kept on cereal rachitogenic rations. Apparently this reaction was not limited to cereal rations or to the rachitic state, because the same trend was observed with rats kept on noncereal rations, which furnished approximately either optimal or excessive amounts of P and optimal amounts of Ca." (Author's summary.)

665a. THOMAS, W. C., JR., HOWARD, J. E., and CONNOR, T. B. Studies on rickets induced by a low calcium diet; effect of starvation, citrates, and succinates. *Johns Hopkins Hosp. Bul.* 101 (3): 123-139. 1957.

665b. WEISSBERGER, L. H., and HARRIS, P. L. Possible vitamin D assay technique with radioactive strontium. *Jour. Biol. Chem.* 144: 287-288. 1942.

"A SrCl_2 soln. contg. radioactive Sr was given by stomach tube to standard rachitic rats and their normal litter mates. Radioactivity detns. were made on the feces and urine of each rat and the results expressed as the fraction of the dose of radioactive Sr excreted over a 5-day period. The normal control group excreted 40-60% of the total and the rachitic group excreted close to 100%. Four other rachitic groups were given one dose of 1.3 units of vitamin D_2 , resp., 3 days, 2 days, 1 day prior to, and at the same time as the SrCl_2 . These excreted 30, 39, 52 and 56%, resp., of the ingested dose, hence vitamin D acts rapidly in promoting the retention of Sr as well as Ca. The same amt. of vitamin did not alter the Sr excretion of the normal rats. In another series, graded doses of vitamin D_2 (0.25-8.0 U.S.P. units) were given to rachitic rats 48 hrs. before the SrCl_2 . These excreted 57-24% of the dose. The quantity of Sr excreted, plotted against the log of the vitamin D dose, gave a nearly straight line." (Chem. Abs. 36: 6208.)

666. WEITS, J. The antivitamin D factor in roughages. *Netherlands Jour. Agr. Sci.* 2: 32-36. 1954.

"The vitamin D (I) present in grass and hay was sepd. from the rachitogenic factor (II) by chromatographic adsorption of the grass fat unsaponifiable residue. Five fractions were obtained, each contg. several carotenoids;

only 2 fractions showed rachitogenic activity, as detd. by feeding peanut oil solns. of each fraction to rats. The true I content of roughages was detd. The I content of the hay samples was not affected by chromatography; these samples did not contain measurable amts. of II. In the case of artificially dried grass, higher I potencies were found after chromatography, showing that these samples contain considerable II. Pptn. of the phyto-sterols with digitonin showed that the II was present in the fraction contg. α - and β -carotenes, supporting the view held by Grant (C.A. 48, 3500d) that the II is identical with carotene." (Chem. Abs. 48: 12262.)

Other Vitamins

667. JACOBSON, L. O., and others. The effect of folic acid on the response of the peripheral blood and blood-forming tissue of the rat to parenterally administered strontium 89. *U.S. Atomic Energy Comm. AECD-3013*, 13 p. 1948.

S. P. Stearner, E. L. Simmons, and M. H. Block, joint authors.

An experiment is described that was primarily designed to determine the effectiveness of folic acid in the prevention or alleviation of macrocytic anemia and leukopenia, which Sr^{89} has been shown to produce.

668. MERZHSKII, M. F., and CHERKASOVA, L. S. Vitamin C metabolism in bone fracture and in burns. *Vitamin Sborn. [Kiev]* 2: 116-122. 1956.

Bone fracture in white mice caused a lowering of vitamin C (I) within the first 24 hours from 1127.5 to 865.1 mg. percent. It returned to the original (normal) within 3 days. It then rose to 1428.7 mg. percent. Bone fracture in guinea pigs lowered the I content from 230 to 136 mg. percent. It continued to fall until on the 15th day I content was 107 mg. percent. It took 2 months before I rose to 184 mg. percent. In burns extending over one-fifth of the skin area of the guinea pig the concentration of I in the adrenals fell considerably below the low level seen in the case of bone fractures and persisted for a longer time. It was 144 mg. percent after 1 month as compared with 237 mg. percent for the controls.

669. NERURKAR, M. K., and SAHASRABUDHE, M. B. Metabolism of calcium, phosphorus, and nitrogen in hypervitaminosis A in young rats. *Biochem. Jour.* 63: 344-349. 1956.

"Oral administration of a pure vitamin A prepn. at a dose 400 times the normal requirement has been shown to produce effects such as reduced food intake, loss of wt., skeletal fractures, and hemorrhages in young albino rats. The degree of toxicity is approx. proportional to the total quantity of vitamin A administered. The effects of administration of large doses of vitamin A on the metabolism of Ca, P, and N have also been studied. A neg. balance for Ca, P, and N sets in and continues for a considerable period after the administration of large doses of vitamin A has ceased. No changes were detected in the levels of Ca and inorg. P of the blood. Very little change in the relative mineral compn. of the bones was observed. Increased excretion of Ca and P is therefore probably due to thinning of the bones. Estn. of vitamin A in the liver suggests that administration of amts. of vitamin A, several times greater than the normal requirements, reduces the absorption of vitamin A from the intestine." (Chem. Abs. 50: 14892.)

670. RYGH, O. Trace elements. III. Importance of strontium, vanadium, barium, thallium, and zinc in scurvy. *Soc. de Chim. Biol. Bul.* 31: 1408-1412. 1949.

"Rats and guinea pigs given diets contg. no ascorbic acid and no methylornarcotine but otherwise complete develop scorbutic symptoms. Large doses of SrSO_4 and small doses of V_2O_5 , added together to the diet, prolong the lives of the scorbutic animals; while small amts. of TlCl_3 (10 mg./kg. diet) and larger amts. of BaCl_2 or ZnSO_4 together shorten the survival period. In all cases methylornarcotine arrests the scorbutic changes in the con-

nective tissues. L-Ascorbic acid does not prevent scurvy unless the diet also includes methylornarcotine (or narcotine)." (Chem. Abs. 44: 6497.)

671. SEN, S. C., and SEN, S. Effect of niacin on the calcium level of blood. *Indian Jour. Med. Res.* 42: 605-612. 1954.

"The intramuscular injection of niacin (25-100 mg.) into 1.3-1.6 kg. rabbits produced increasing blood sugar levels with increasing niacin dose. With the hyperglycemia an increase in blood Ca occurred. A similar hyperglycemia and elevated serum Ca occurred after the intravenous injection of glucose." (Chem. Abs. 49: 7077.)

HORMONES

General

672. DiPAOLO, E., GARAGNANI, A., and VANCINI, B. Various homeostatic effects of calcium ions in insulinic hypoglycemia. *Arch. di Patol. e Clin. Med.* 33: 351-364. 1957.

673. DONTENWILL, W., and MANCINI, A. M. Experimental research on the influence of hormones on bone growth in rabbits. *Beitr. z. Path. Anat. u. Allg. Path.* 117: 50-64. 1957.

674. GIRAUD, G., LEVY, A., and BORJON, P. Endocrine regulation of renal excretion of calcium (review). *Montpellier Méd.* 48: 419-434. 1955.

675. GUEL BENZU, M. D. Relation between "oligo-elements" and biological catalysts. II. *Monitor de La Farm. y de la Terap.* 54: 301-304. 1948.

"The following relationships are discussed: Br and pituitary; I, Br, and As and the thyroid; Ca, Mg, and Sr and the parathyroid; Zn, Co, Cd, and Ni and the pancreas; Mg, Mn, and Li and the gonads; Fe and the antipernicious anemia factor; and Cu and the liver." (Chem. Abs. 42: 8298.)

676. KAWIN, B. Effects of cortisone acetate on the distribution and excretion of radioyttrium. *Nature* 179: 871-872. 1957.

"Rats injected with 10 μ c. of ionic carrier-free $Y^{91}Cl_3$ received either a single injection of cortisone acetate (45 mg./kg. body wt.) 18 min. prior to the injection of Y or 3 injections of cortisone at 72, 24, and 20 min. before the Y injection. Apart from an increase in the concn. of Y^{91} in the plasma, a single dose of cortisone was ineffective. Three injections of cortisone reduced the concn. of Y^{91} in liver and spleen by 50%; this may be a result of the depressed phagocytosis of Y^{91} by reticulo-endothelial elements of these tissues." (*Internatl. Abs. Biol. Sci.* 8: 1617.)

677. LAYANI, F., and CHAOUAT, Y. The role of ovarian, adrenal, and hypophyseal secretions on calcium fixation by bones. *Semaine Hôp.* 31: 2887-2890. 1955.

"Female rats receiving an equil. diet were divided into groups of (a) controls, (b) bilaterally ovariectomized, (c) bilaterally adrenalectomized, (d) as (b) plus (c), (e) daily injection of 40 mouse units hypophyseal follicle-stimulating hormone, (f) as (b) plus (e), (g) as (c) plus (e), (h) as (d) plus (e). The adrenalectomized lots received as beverage a soln. contg. 0.7% NaCl and 3% glucose. After 30-days treatment the animals were sacrificed and their femurs dried, weighed and Ca detns. performed. Ca content in mg./100 mg. bone were: (a) 20.7, (b) 19.7, (c) 20.0, (d) 21.0, (e) 21.9, (f) 21.5, (g) 22.0, and (h) 20.4." (Chem. Abs. 50: 2800.)

678. PEARSON, O. H. Metabolic studies related to endocrine extirpative procedures. *Cancer [Phila.]* 10: 799-804. 1957.

"Urinary Ca levels were used to evaluate the effects of alterations in endocrine environment on breast cancer

growth. The use of Ca studies was limited to patients with osseous disease sufficiently active to cause abnormalities in Ca metabolism. Several patients showed spontaneous fluctuations in Ca excretion during the menstrual cycle with improvement after oophorectomy. Progesterone had no effect on the Ca excretion but estrogen caused a rise to pathol. levels in these cases. The effects of adrenalectomy, oophorectomy, and adrenalectomy, and of hypophysectomy in breast cancer patients were followed by means of the urinary Ca levels." (Chem. Abs. 52: 3122.)

679. SELYE, H., and BOIS, P. The role of corticoids in conditioning the gastric mucosa to certain toxic actions of ergocalciferol. *Brit. Jour. Nutr.* 11: 18-22. 1957.

"Subcutaneous injections of ergocalciferol, which in itself, causes no pathol. calcification, induced Ca deposition in the gastric mucosa if given simultaneously with cortisol acetate. Deoxycorticosterone acetate did not share this sensitizing effect of cortisol acetate; indeed it appeared to inhibit it. Conclusion: Adrenocortical steroids exerted a selective conditioning effect upon the ability of ergocalciferol to induce pathol. changes in the gastric mucosa of the rat." (Chem. Abs. 52: 3131.)

Parathyroid Hormone

680a. AIVAZYAN, L. A. Spleen and regulation of calcium metabolism and activation of parathyroid hormone. *Uchen. Zap. Azerbaidzhansk. Gosud. Univ. im. S. M. Kirova* 9: 77-82. 1956.

"Splenectomy caused a negligible (up to 10%) drop of Ca in blood plasma. Parathyroid hormone introduced postoperatively was not able to bring Ca to normal level. Splenectomy and thyroidectomy led to a considerable drop of Ca in blood plasma. When splenectomy was performed after introduction of parathyroid hormone, the activity of the latter was decreased. Introduction of parathyroid hormone after splenectomy and parathyroidectomy did not stop the rapid drop in Ca content." (Chem. Abs. 52: 1410.)

680b. ALLARA, E. Histochemical features of parathyroid glands in old people. *Gior. di Gerontol.* 5: 751-752. 1957.

"The examn. of 47 glands showed ribonucleic acid to be variable in the various cell types (absent in oxyphilic cells, abundant in the cytoplasm of chief cells; present in high concn. in small nuclei of clear cells); some increase of glycogen, paralleling the increase of the clear cell no.; and an intense Okamoto reaction for Zn in the granules of oxyphilic cells. The latter fact is interpreted to mean that the cells are very rich in carbonic anhydrase." (Chem. Abs. 52: 4786.)

680c. BACON, J. A., PATRICK, H., and HANSARD, S. L. Some effects of parathyroid extract and cortisone on metabolism of strontium and calcium. *Soc. Expt. Biol. and Med. Proc.* 93: 349-351. 1956.

"Rats were given 5 microcuries of Ca^{45} or Sr^{90} subcutaneously 24 hrs. before the hormone injections. Parathyroid ext. increased the urinary excretion of Ca and Sr and increased the deposition of both elements in the kidney tissue. Cortisone prevented accumulation of Ca and Sr in kidney tissue but did not influence urinary excretion or diuresis." (Chem. Abs. 51: 3829.)

681a. BARTELS, E. D. Action of the parathyroid hormone. *Acta Endocrinol.* 15: 71-81. 1954.

A review with 61 references.

681b. BRONNER, F. Effects of parathyroid extract on calcium and sulfur metabolism. *Fed. Proc.* 16: 158. 1957.

" Ca^{45} or Sr^{90} -sulfate was injected once intraperitoneally into 31-day old rats. Starting 24 hours later 50 units of parathyroid extract (PTE) were given twice daily for a maximum of 500 units. The Sr^{90} levels in the blood, urine, pelt, and liver were higher in the treated rats than

in the controls. The differences were small but consistent. Neither chemical nor autoradiographic analyses, however, revealed differences in the levels of S^{35} in the skeleton. In the case of calcium, the treated rats excreted 6-18 times more Ca^{45} in their urine than the controls, but only 4-8 times more Ca^{40} . In one experiment, in which the same amount of Ca^{45} had been administered over a 3-day period before administration of PTE was begun, treatment increased Ca^{45} excretion by the same factor by which Ca^{40} excretion had been increased. These observations are interpreted as meaning that PTE influenced the mobilization of the most recently deposited calcium. Autoradiographic and chemical analyses also showed that there was less Ca^{45} in the metaphyses of tibias from the treated than in tibias from the control animals. The PTE may have had an effect on bone deposition as well as resorption, for in the cartilage plates of the treated animals the mature chondrocytes were more numerous and those closest to the trabeculae were more engorged than in the controls." (Author's abstract.)

681c. DAVIES, B. M. A., GORDON, A. H., and MUSSETT, A. V. Plasma calcium assay for parathyroid hormone using parathyroidectomized rats. *Jour. Physiol.* 125: 383-395. 1954.

"A triple cross-over assay for estg. Ca activity of parathyroid hormone (I) is described, which employs 24-hr. parathyroidectomized hooded rats; it measures increases in plasma Ca 21 hrs. after injection of I. The response is dependent on the initial plasma Ca and Mg content, to correct for which an expression has been derived. Av. limits of error are 64-158%, with responses diminished during the summer months." (Chem. Abs. 48: 12864.)

682. DAWSON, J., WEIDMANN, S. M., and JONES, H. G. Effect of parathormone on the phosphorus-32 uptake by the bones of rabbits and cats. *Biochem. Jour.* 66: 116-122. 1957.

"The major effect of parathormone on bones in both cats and rabbits is to decrease the uptake of phosphates into the endosteal layer of the diaphyseal shafts, as shown by tracer expts. with P^{32} . This effect of parathormone can be observed in nephrectomized rabbits. It is concluded that none of the effects of parathormone on P^{32} uptake can be explained on the basis of exchange and recrystn. of bone minerals. The primary effect of parathormone is an inhibition of osteoblastic activity which decreases the P^{32} uptake into the area of bone where osteoblastic activity is max., namely, the endosteal layer." (Chem. Abs. 51: 14053.)

683. ELLIOTT, J. R., and FREEMAN, S. Kidney-parathyroid relation to plasma citric acid and calcium. *Fed. Proc.* 14: 43-44. 1955.

"Nephrectomy is followed by an increase in the plasma citric acid and calcium of dogs, rats, rabbits, and guinea pigs. The peak of hypercitricemia occurs 4 hours after nephrectomy in the rat, and by 8 hours the citric acid value has returned to normal (2.5-3.5 mg. percent). Ureteral ligation causes no change in the plasma concentration of calcium or citric acid. Parathyroidectomy reduces the fasting plasma citrate concentration in the rat by approximately 1 mg. percent. Parathyroidectomy at the time of nephrectomy reduces the average 4-hour elevation of citric acid from 18 mg. percent to 9 mg. percent in the rat, and the hypercalcemic response to nephrectomy is abolished. If parathyroidectomy precedes nephrectomy by 4 days, there is no significant rise in citric acid or calcium after nephrectomy. Sixty I.U./day of parathyroid extract (Lilly) for 4 days after parathyroidectomy results in a normal plasma citric acid response 4 hours after nephrectomy (18 mg. percent). The same total dose of hormone given to parathyroidectomized rats as a single injection 16 hours before nephrectomy and 4 days after gland extirpation has only a slight effect on the 4-hour response to nephrectomy. Fluoroacetate administration raises the plasma citrate concentration before and after nephrectomy, but the increase in concentration after nephrectomy in

normal and fluoroacetate poisoned rats is essentially the same. The average serum calcium concentration is increased slightly in the fluoroacetate animals." (Author's summary.)

684. ELLIOTT, J. R., and FREEMAN, S. Parathyroid function and the plasma citric acid and calcium response to nephrectomy. *Endocrinology* 59: 181-189. 1956.

"Nephrectomy produced transient low blood levels of citric acid and Ca in the rat, rabbit, and guinea pig but not in the baboon and monkey. Parathyroidectomy prior to nephrectomy abolished the above response in the rat and rabbit. Parathyroid ext. restored the response to nephrectomy of the parathyroidectomized rat, but vitamin D failed to do so." (Chem. Abs. 51: 2826.)

685. ENGFELDT, B., HJERTQUIST, S. O., and STRANDH, J. R. E. Parathyroid function in long-term dietary experiments. *Acta Endocrinol.* 15: 119-128. 1954.

"With a diet rich in P fed to rats over more than a year's period, hyperfunction and hyperplasia of the parathyroids ensue. The value of blood P soon decreases and remains low while Ca is normal or only slightly reduced. A diet rich in Ca produces atrophy of the parathyroids. The blood Ca, initially high, falls to below normal. The blood P increases during the later part of the expt." (Chem. Abs. 48: 5314.)

686. GAILLARD, P. J. Parathyroid gland and bone *in vitro*. *Schweiz. Med. Wchnschr.* 87: 447-450. 1957.

"It has been previously reported (Gaillard, Exp. Cell Res., 1955, Suppl. 3, 154) that parathyroid gland tissue was capable of initiating resorption in living explants of parietal bone of full term mouse embryos. This effect has now been reproduced using a commercial prep. of parathormone." (Internatl. Abs. Biol. Sci. 8: 2025.)

687. GARCÍA, F. M., CARRIL, J. N., and ORTIZ DE LANDAZURI, E. Response of the calcium and phosphate metabolism to the hypercalcemia test in hypoparathyroidism. *Rev. Clin. Españ.* 55: 72-80. 1954.

"The findings of Howard, *et al.* (C.A. 47: 10679i), are confirmed." (Chem. Abs. 49: 4853.)

688. GORDON, A. H. The parathyroid hormone. *Cong. Internatl. de Biochim., 2^e Cong. Paris, Résumés Commun.* 1952: 53-54. 1952.

"Although large amts. of parathyroid hormone (I) are required to affect the serum Ca level of rats, after parathyroidectomy a max. increase in the excretion of urinary phosphate can be obtained with as little as 20 U.S.P. units of I. Preliminary purification of I was done by pptn. with acetone followed by electrophoresis in buffers contg. Ca ions, whose solubilizing action permits investigation at much higher pH values than those previously used. Electrophoresis at pH 6 of material prepd. according to L'Heureux, *et al.* (C.A. 41: 4532f) demonstrated at least 3 different proteins. These were electrophoretically sepd. in a flat trough packed with starch granules to stabilize the liquid. The fractions showed both qual. and quant. biol. differences. That with the highest mobility (II) was active at 1 γ /rat. Injections of larger amts. did not affect the phosphate of the urine. Higher concns. of the material of lower mobility were needed to affect phosphate excretion, although the response was never much below the max. of II." (Chem. Abs. 49: 5631.)

689. HAGGE, W. The effect of dihydrotachysterol on the mineral components of serum. *Arzneimittel-Forsch.* 7: 674-678. 1957.

"The influence of parathormone (I), dihydrotachysterol (II), and vitamin D₃ (III) upon the Ca, K, Na, P, Cl, Mg, and phosphatase content of the serum of normal and parathyroidectomized dogs has been studied. Subcutaneous injection of 5 units I/kg. in normal dogs caused an increase of Ca of 3 mg. % within 1-3 hrs. followed by 2 mg. % P increase. Oral doses of 0.1 mg. II/kg. caused increase of Ca and K after 16-20 hrs., followed by increased

P in normal dogs. In parathyroidectomized animals the P curve showed the reciprocal image of the Ca curve. III (0.5-1 mg./kg.) raised Ca and K levels in parathyroidectomized dogs with simultaneous lowering of P. No effect was observed in normal animals." (Chem. Abs. 52: 4787.)

690. HOWARD, J. E. Present knowledge of parathyroid function, with especial emphasis upon its limitations. Ciba Found. Symp. Bone Structure and Metabolism 1955: 206-221. 1956.

"A review and interpretation on the action of parathyroid hormone (I) on the Ca and P metabolism of bones and other tissues. Besides having a structural function, bone serves as the site of a physiol. system which stabilizes the concn. of Ca in the body fluids. I is a factor involved in the action of this system." (Chem. Abs. 52: 3090.)

691. HOWARD, J. E., and CONNOR, T. B. A discussion of calcium homeostasis; the role of the skeleton and some speculations on the part played by the parathyroid hormone. *Biblioth. Paediatrica* 58: 230-244. 1954.

692. JUSTIN-BESANCON, L., KLOTZ, H. P., and GOUDAL, H. Modifications of dental calcification in the parathyroidectomized rat. (Preventive and curative action of calciferol implants.) *Ann. d'Endocrinol.* [Paris] 16: 179-198. 1955.

"During total parathyroidectomy, 19% of the rats die; of the survivors 19% of the adult and 64% of the young animals die in a few days after the operation. Among the surviving animals, 92% have dental lesions and their teeth break. If a pellet of 10 mg. calciferol (with 15 mg. cholesterol or 15 mg. lactose as a substrate) is inserted during parathyroidectomy, the death rate is the same as the death rate of the controls (16%) but if the pellet is inserted 15 to 30 days before parathyroidectomy, the death rate is lower (6%) than the death rate of the controls. Calciferol protects against teeth breaking, lengthens the time of survival to more than 4 months, and regulates incomplete dentine calcification which is disturbed by parathyroidectomy; it is not toxic at a dose of 50 mg. The size and shape of the pellets is not altered after their insertion. The loss of wt. of the pellets is less than 0.5 mg. if the substrate is cholesterol and it is less than 5 mg. if the substrate is lactose." (Chem. Abs. 50: 2782.)

693. KENNY, A. D. Suppression of calcium-mobilizing activity of parathyroid extracts by inorganic phosphate. *Endocrinology* 60: 423-426. 1957.

"The Ca-mobilizing activity of a crude parathyroid ext. (20 units/ml. in the rat assay of Munson, C.A. 49, 12646c) was significantly reduced by phosphate at a level of 4 mg. P/ml. Simultaneous injections of hormone and PO_4 at different sites gave no reduction of activity, and the activity of a mixt. of hormone and PO_4 was restored by dialysis, suggesting that the loss of activity is due to a direct interaction of the components." (Chem. Abs. 51: 8239.)

694. KRANE, S. M. Parathyroid damage in man. Mechanism of effect of serum levels of calcium and phosphorus. *Jour. Clin. Endocrinol. and Metabolism* 17: 386-389. 1957.

"Hypocalcemia was observed in 7 of 10 patients following parathyroid damage incidental to thyroidectomy for hyperthyroidism. Little or no increase in serum inorg. P accompanied the fall in serum Ca. The results support the hypothesis that the parathyroids act directly to maintain the level of Ca in serum." (Chem. Abs. 51: 7559.)

695. LASKIN, D. M., and ENGEL, M. B. Bone metabolism and bone resorption after parathyroid extract. *Amer. Med. Assoc. Arch. Path.* 62: 296-302. 1956.

"In weanling rabbits treated with parathyroid ext., the aerobic respiration of bone slices was reduced approx. 40% from that of the controls, largely as the result of depression of the succinoxidase system. Intracellular

glycogen in osteoblasts and osteocytes was decreased, with a disaggregation of the glycoprotein ground substance." (Chem. Abs. 51: 3818.)

696. McLEAN, F. C. The parathyroid hormone and bone. *Clin. Orthopaedics* 9: 46-60. 1957.

A review of parathyroid metabolism with 62 references.

697. McLEAN, F. C., and BLOOM, W. Calcification and ossification: Mobilization of bone salt by parathyroid extract. *Amer. Med. Soc. Arch. Path.* 32: 315-333. 1941.

"The mobilization of bone salt in puppies after large doses of parathyroid ext. was demonstrated by the use of $AgNO_3$. During the resorption of bone, a calcifiable substance appears in the intercellular spaces of the bone marrow, and bone salt is deposited in this. It is suggested that this substance, when present in normal bone, may aid in the calcification of the collagenous fibers. Later, and during recovery, the bone salt is taken up by the macrophages of the marrow but not by osteoclasts." (Chem. Abs. 36: 551.)

698. MANUNTA, G., SAROFF, J., and TURNER, C. W. Paper electrophoretic study of Ca^{45} binding in sera of normal, parathyroidectomized, and estrogen-treated rats. *Soc. Expt. Biol. and Med. Proc.* 94: 790-791. 1957.

"In normal rats most of the circulating Ca^{45} was bound to serum albumin and α -globulin. After parathyroidectomy Ca^{45} decreased in the albumin fraction and increased in the α -globulin. In male rats treated with estrogen most of the Ca^{45} was present in the β - and γ -globulin fractions." (Chem. Abs. 51: 12273.)

699. MANUNTA, G., SAROFF, J., and TURNER, C. W. Relationship between estradiol and parathyroid on retention of Ca^{45} in bone and blood serum of rats. *Soc. Expt. Biol. and Med. Proc.* 94: 785-787. 1957.

"In normal male rats given intraperitoneal injections of small doses of $Ca^{45}Cl_2$, administration of estrogen increased the radioactivity of the blood serum while bone radioactivity remained unchanged. Parathyroid ext. depressed radioactivity of both bone and serum, but when estrogen was given in addn., radioactivity was increased in both. Parathyroidectomy depressed the radioactivity of bones and serum but estrogen again increased the radioactivity of bones slightly and of serum significantly. These findings indicate that estrogen plays a role in Ca metabolism independent of the parathyroid hormone in aiding retention of Ca." (Chem. Abs. 51: 12273.)

700. MARNAY, C., PRELOT, M., and RAOUL, Y. Hypercalcemic activity in normal or thyroparathyroidectomized dogs of a lipide fraction of parathyroid gland extracts. *Acad. des Sci. Paris, Compt. Rend.* 243: 681-683. 1956.

"The authors have confirmed in normal and thyroidectomized dogs the previously reported hypercalcemic activity of a lipide fraction of parathyroid gland exts. This hypercalcemic action suppresses tetanus in parathyroid-deprived animals and improves their general condition." (Chem. Abs. 51: 11550.)

701. MUNSON, P. L. The role of the parathyroids in calcium and phosphorus metabolism. *N.Y. Acad. Sci. Ann.* 60: 776-796. 1955.

"Rats, maintained on a low-Ca or normal diet and parathyroidectomized at 50-60 days of age, showed an immediate decrease of serum Ca which was not dependent on a prior rise in serum inorg. P. Serum inorg. P first fell and then rose. Two new biol. assay methods are described, based on the Ca-mobilizing activity and phosphaturic activity, resp. Partial sepn. of these 2 activities was possible, suggesting that more than one hormone may be assoc. with the parathyroid gland. The parathyroids were shown to influence the milk Ca levels of lactating rats." (Chem. Abs. 49: 12646.)

702. PICARD, J. Action de la parathormone dans le métabolisme phospho-calcaïque. Presse Méd. [Paris] 63: 1320-1324. 1955.

703. POLIN, D. Mobilization of blood calcium and phosphorus in *Gallus domesticus*. I. Effects of parathyroid and gonad hormones, starvation, and shell deposition. Univ. Microfilms Pub. 14050, 119 p. 1955.

704. POLIN, D., STURKIE, P. D., and HUNSAKER, W. The blood calcium response of the chicken to parathyroid extracts. Endocrinology 60: 1-5. 1957.

"Plasma Ca in chicks and mature cocks was increased 2.1 mg. % 3-4 hrs. after subcutaneous injection of 100 units of parathyroid ext. Laying hens showed an even greater response. In the chick the log-dose response was linear in the range 50-200 units." (Chem. Abs. 51: 5289.)

705. RAOUL, Y., MARNAY, C., and PRELOT, M. Extraction of a non-nitrogenous substance from the parathyroid exerting an effect on blood calcium. Acad. des Sci. Paris, Compt. Rend. 240: 1151-1153. 1955.

"Parathyroid exts. from horse, beef, and pig, prepd. according to L'H., *et al.*, were either boiled with abs. EtOH or extd. with 3:1 EtOH:Et₂O at -40°, yielding a N-free lipid fraction highly active in producing hypercalcemia in a rabbit and an inactive protein residue. The active lipid exts. did not give a ninhydrin reaction but did give color reactions characteristic of sterols." (Chem. Abs. 49: 11761.)

706. SEKIKAWA, A. Parathyroidectomy in rats. Nippon Yakurigaku Zasshi 52: 520-539. 1956.

"Parathyroidectomy decreased the Ca content in rat serum; the decrease was largest, 54-8% of the normal value, approx. 10 days after the operation. After 2 months, it recovered to approx. 70% of the original level and maintained the value for over half a year. Injection of 5-10 cc. 10% Na₂HPO₄ soln. in the parathyroidectomized rats, from 8 days to 6 months after the operation, caused immediate convulsion and killed them within 2 hrs. The normal animals suffered from no such toxic actions. Strychnine nitrate, in the dose of 10 cc. of 0.01% soln., caused severe convulsion and killed the parathyroidectomized rats, while it caused only slight convulsion in normal rats. Both normal and parathyroidectomized rats showed no difference in giving paralysis at the site of injection of tetanus toxin. Injection of 1-5 cc. of 6.6% MgSO₄ soln. caused paralysis in the parathyroidectomized rats and killed them; the effect was much smaller in the normal rats. Parathormone (Lilly) (1 cc.) increased the serum Ca content more markedly in the parathyroidectomized rats than in the normal rats. Oral administration of 3 1-γ doses of vitamin D with 2 days' interval did not increase the serum Ca content in the parathyroidectomized rats; but it inhibited paroxysm of tetany to some extent. The isotonic soln. of CaCl₂ showed no influence on the serum Ca contents both in the normal and parathyroidectomized rats by oral administration; but no paroxysm of tetany was produced in the latter by the administration. CaCl₂ in 2 and 6% solns. increased the serum Ca content to some degrees in the parathyroidectomized rats; no influence was observed on the paroxysm of tetany. Simultaneous administration orally of vitamin D and CaCl₂ increased the serum Ca content and inhibited the paroxysm in the parathyroidectomized rats to considerable extents. Those parathyroidectomized rats fed with high Ca and low P diet showed loss of body wt. while those fed with ordinary diet showed the gain. Administration of vitamin D antagonized this loss of body wt. Expts. with Ca⁴⁵Cl₂ indicated that the distributions of Ca⁴⁵ 40 hrs. after the administration showed no difference between the normal and the parathyroidectomized rats. The Ca⁴⁵ content in the intestine within 3 hrs. after the administration was markedly smaller in the parathyroidectomized rats than in the normal rats, indicating that the Ca absorbed there is more rapidly transported to other needy organs. The parathyroidectomy apparently augmented the intestinal movement and the intestinal absorption of Ca. Within 12 hrs.

after the administration, the Ca⁴⁵ content in femur was larger in the parathyroidectomized rats than in the normal ones. After 12 hrs., the excretions of Ca into urine and feces were larger in the parathyroidectomized rats." (Chem. Abs. 51: 18307.)

707. SMITH, V. R., STOTT, G. H., and WALKER, C. W. Parathyroidectomized goats. Jour. Anim. Sci. 16: 312-317. 1957.

"In both the kid and mature goats thyroparathyroidectomy resulted in a marked drop in the serum Ca but no marked change in the plasma inorg. P. Subjecting the kid goats to a low-Ca ration resulted in further decrease of the serum Ca. Four of the six thyroparathyroidectomized kids died from parathyroid deficiency. Pregnant goats showed tetany within one week after removal of the parathyroids. After parturition no further symptoms of parathyroid deficiency were observed. There was no udder development or lactation in the thyroparathyroidectomized goats." (Chem. Abs. 51: 14931.)

708. STOTT, G. H., and SMITH, V. R. Parathyroidectomy of calves. Jour. Dairy Sci. 40: 893-896. 1957.

"A study of reactions of calves to removal of the internal parathyroids along with the thyroid glands, removal of the external parathyroids, and thyroparathyroidectomy was made. When only the internal parathyroids and the thyroid glands or the external parathyroids were removed, there was no tetany and little effect on the serum Ca and plasma inorg. P. Thyroparathyroidectomy resulted in an abrupt, marked lowering of the serum Ca, a less marked lowering of the inorg. plasma P, tetany, and death. An elevation of the inorg. plasma P occurred just prior to death." (Chem. Abs. 51: 18253.)

709. STOTT, G. H., and SMITH, V. R. Parturient paresis. VIII. Results of parathyroidectomy of cows. Jour. Dairy Sci. 40: 897-904. 1957.

"Nonlactating pregnant cows and non-pregnant lactating dairy cows were thyroparathyroidectomized. Blood serum Ca and plasma inorg. P analyses were made at various intervals before and after thyroparathyroidectomy. A marked decrease in serum Ca and less of a decrease in inorg. P occurred after removal of the parathyroid glands. None of the cows exhibited symptoms of milk fever, although the serum Ca of several of the cows decreased to the range where milk fever symptoms occur. The natural diet of ruminants has a high Ca:P ratio and, on this diet, the adult ruminant cow can maintain pregnancy, parturite, and lactate in the absence of parathyroids." (Chem. Abs. 51: 18253.)

710. TALMAGE, R. V. Maintenance of serum calcium levels by parathyroid action on bone and kidney. N.Y. Acad. Sci. Ann. 64: 326-335. 1956.

"Data show that removal of the parathyroids of the rat lowers the kidney threshold for phosphate excretion while simultaneously raising the threshold for Ca excretion. An increase in circulating parathyroid hormone raises the labile bone fraction of Ca and phosphate, while the renal threshold for Ca is raised, reducing to a min. the amt. of Ca needed to adjust plasma levels. Effect of the hormone on phosphate is to raise simultaneously labile bone phosphate while lowering the kidney threshold for phosphate excretion. Under normal physiol. conditions the effect on phosphate is relatively insignificant and plays no part in Ca control or in the overall economy of Ca utilization. When increased amts. of hormone are present, the phosphate threshold is decreased below the rising phosphate level of labile bone, resulting in increased excretion of phosphate from the labile bone component, with concurrent removal of Ca from this pool. Phosphate and Ca are then replaced in the labile component from the stable component; Ca lost from the bone would immediately be lost via the urine. Thus the increased secretion of phosphate may lead to appreciable losses of Ca and phosphate from bone. It is suggested that in man the increased phosphate excretion may actually be the primary cause of hyperparathyroid bone disorders." (Chem. Abs. 51: 18278.)

711. TALMAGE, R. V., and ELLIOTT, J. R. Changes in extracellular fluid levels of calcium, phosphate and citrate ions in nephrectomized rats following parathyroidectomy. *Endocrinology* 59: 27-33. 1956.

"Peritoneal lavage of nephrectomized rats gave control levels of 7 mg. % Ca in the peritoneal wash. Subsequent parathyroidectomy reduced this to 3.5 mg. %, but parathyroid ext. restored the Ca level to the control value. Similar changes occurred in phosphate and citrate concns. in the wash." (Chem. Abs. 50: 17064.)

712. TALMAGE, R. V., and ELLIOTT, J. R. Differential removal of calcium-40 and calcium-45 from bone as influenced by the parathyroids and by citric acid. *Internatl. Jour. Appl. Radiation and Isotopes* 2: 246-247. 1957.

"The ability of bone to supply calcium to the extracellular fluid compartments was studied by the technique of continuous peritoneal lavage in male albino rats. Radiocalcium (Ca^{45}) was administered either 18 hours or 2-3 weeks prior to the start of the lavage. The lavage fluid consisted of a 0.84 percent NaCl solution containing 1.5 percent glucose. Citric acid to a concentration of 0.015 percent was added in some experiments. Fluid was added to and withdrawn from the cavity through an indwelling glass inguinal catheter while the animals were maintained under light nembutal anesthesia.

The removal of radiocalcium when injected within 24 hours of the start of the lavage was not affected either by parathyroidectomy or the addition of citric acid to the peritoneal rinse, despite the marked changes produced in the total calcium removed by these two experimental techniques. If the radiocalcium was injected more than 2 weeks prior to the lavage, both radiocalcium and total calcium varied together. These experiments are interpreted to show that the bone supplies calcium to the extracellular fluid by two mechanisms. One, which is not affected either by the parathyroid hormone or by exogenous citric acid, is a basic phenomenon of equilibration between the extracellular fluid and those portions of the bone with which it is in close contact. The other is a mechanism apparently controlled by the parathyroid and influenced by exogenous citric acid. It is concerned with the removal of calcium from areas not in ready contact with the extracellular fluid spaces, and it adds calcium to the extracellular fluid in concentrations above the solubility of the apatite crystals of bone. These experiments are suggested to show further the close relationship of parathyroid hormone, citric acid, and calcium metabolism." (Author's abstract.)

713. TALMAGE, R. V., and others. Parathyroid influence on calcium ion equilibration between bone and extracellular fluid. *Fed. Proc.* 16: 127. 1957.

J. R. Elliott, R. Davis, and A. C. Enders, joint authors. "The influence of parathyroids on the ability of bone to supply calcium to extracellular fluid was studied in nephrectomized rats using a peritoneal lavage technique; 250-g. rats, maintained on a calcium-deficient diet, were nephrectomized and parathyroidectomized the day preceding use. Lavage fluid (0.84 percent NaCl and 1.5 percent glucose) was added and drained through an inguinal catheter. Equilibration levels, rates, and effect of this stress on bone were studied by varying the time the fluid remained in the animals in repeated washings covering periods up to 12 hours. The following results were obtained: (1) Animals with intact parathyroids were able to supply calcium to the extracellular fluid at a higher rate and to higher levels, even when maintained under continuous stress up to 12 hours, than were their parathyroidectomized controls. Significant differences in the calcium supplied were noted even in 10-minute washes. (2) Animals without parathyroids were always capable of supplying calcium to extracellular fluid, though at a rate and to a level of approximately 50 percent of their controls. (3) Areas of bone taken from animals with intact glands showed marked increases in numbers of osteoclasts after as little as 6 hours of stress. Parathyroidectomized animals showed no osteoclastic increase. (4) Although parathyroid tissue removed from animals at the end of the experimental period showed some signs of stress, no marked histochemical changes were observed. (5) Despite the fact that

calcium rates were maintained throughout the stress period, citric acid levels of wash dropped rapidly after the first wash in both intact and parathyroidectomized rats." (Author's abstract.)

714. TALMAGE, R. V., ELLIOTT, J. R., and ENDERS, A. C. Parathyroid function as studied by continuous peritoneal lavage in nephrectomized rats. *Endocrinology* 61: 256-263. 1957.

"Peritoneal lavage in nephrectomized rats with isotonic, Ca-free, PO_4^{3-} -free fluid showed that the Ca level in the equilibrated fluid was maintained at a slightly lower level after parathyroidectomy, while the citrate level dropped steadily to about $\frac{1}{2}$ normal. The mobilized Ca is removed from the bone in the absence of parathyroid activity. Parathormone appears to affect the level of equilibration of Ca between cellular and extracellular compartments." (Chem. Abs. 51: 18203.)

715. TALMAGE, R. V., and KRAINTZ, F. W. Progressive changes in renal phosphate and calcium excretion in rats following parathyroidectomy or parathyroid administration. *Soc. Expt. Biol. and Med. Proc.* 87: 263-267. 1954.

"Following parathyroidectomy there is an immediate drop in urinary phosphate and a rise in urinary Ca. Within 24 hours the excretory rates for both these ions return to normal despite the continued high phosphate and low Ca levels of the serum. After administration of parathyroid ext. to normal rats there is an immediate drop in urinary Ca and a rise in urinary phosphate. After about 24 hours the excretory rate for Ca returns to or rises above normal, while urinary phosphate continues high. These results are explained on the basis that immediate changes in renal excretory rates resulting from changes in parathyroid hormone titer are due to shifts in the renal thresholds for these ions. Excretion changes after the serum level has become adjusted to the new thresholds are considered to be due to extrarenal changes modifying the entry of these ions into the serum." (Chem. Abs. 49: 2584.)

716. TALMAGE, R. V., KRAINTZ, F. W., and BUCHANAN, G. D. Effect of parathyroid extract and phosphate salts on renal calcium and phosphate excretion after parathyroidectomy. *Soc. Expt. Biol. and Med. Proc.* 88: 600-604. 1955.

Changes in renal phosphate and Ca excretion in the 24 hours following parathyroidectomy in the rat were studied. Excretion of phosphate nearly ceases until serum phosphate has increased to about 13 mg. percent. It increases suddenly about 16 hours after the operation or sooner if Na_2HPO_4 is injected intravenously to hasten the rise in serum phosphate. Injection of parathyroid extract also hastens return toward normal excretion rates by altering the renal mechanism for excretion. Ca excretion increases considerably at parathyroidectomy but declines as the serum level falls and returns to a normal rate at about the 16th hour. Parathyroid extract hastens the return of Ca excretion toward the normal rate.

717. TALMAGE, R. V., KRAINTZ, F. W., and KRAINTZ, L. Effect of parathyroids on radiocalcium uptake and exchange in rat tissues. *Soc. Expt. Biol. and Med. Proc.* 80: 553-557. 1952.

"Rats were injected intraperitoneally with 20 microcuries of $\text{Ca}^{45}\text{Cl}_2$. The uptake by various tissues is shown in graphs. The amt. of carrier Ca injected with the Ca^{45} had considerable influence on the results. The uptake of carrier-free Ca^{45} by bone can be divided into 2 time periods. The first 6 hours is the exchange period in which the Ca^{45} is equilibrating with Ca in blood, soft tissues, and that portion of the Ca of bone which is either in ionic form or in loose org. union. The straight-line portion of the graph following this period is termed the turnover-rate period and is considered to indicate the rate at which Ca is being actively laid down by the long bones. The exchange period was not markedly affected by absence of the parathyroids but the turnover-rate was decreased." (Chem. Abs. 46: 10342.)

718. TOVERUD, S. U., and MUNSON, P. L. The influence of the parathyroids on the calcium concentration of milk. *N.Y. Acad. Sci. Ann.* 64: 336. 1956.

"The importance of the parathyroids in the regulation of overall calcium metabolism led us to investigate the possibility that parathyroid hormone may influence the calcium-concentrating function of lactating mammary glands. Experiments on lactating rats revealed changes in the composition of the milk 24 hours after removal of the parathyroid glands.

The concentration of calcium in the milk was increased markedly in spite of a greatly depressed serum calcium level. The milk appeared obviously thicker, and there was an increase in the total solids. The increase in calcium content, however, was not entirely accounted for by the reduction in percentage of water, as the calcium concentration, expressed as milligrams per gram of milk solids, was significantly higher after parathyroidectomy than in control sham-operated rats. Administration of parathyroid extract immediately after parathyroidectomy prevented the decrease in water content of the milk as well as the fall in serum calcium. The increase in calcium concentration of the milk was not so clearly prevented." (Author's abstract.)

719. TWEEDY, W. R. The effect of parathyroid extract upon the distribution, retention, and excretion of labeled strontium. *Jour. Biol. Chem.* 161: 105-113. 1945.

"The percentage of labeled Sr was detd. in the tissues and excreta of untreated rats and of rats treated with parathyroid ext. after a single dose of radioactive SrCl_2 had been injected intraperitoneally. One injection of 5 cc. (500 Hanson units) of parathyroid ext. had no effect on the retention of labeled Sr in the femurs or soft tissues, nor in the excretion for a 24-hr. period after the administration of the labeled Sr. If 5 cc. of parathyroid ext. was injected and 24 hrs. later followed by a 2nd injection of 5 cc. of ext. and labeled Sr, the following observations were made: (a) a decreased retention of Sr in the femurs, (b) a decreased fecal excretion, (c) an increased urinary excretion of Sr, and (d) a marked retention of Sr in the kidneys." (Chem. Abs. 40: 1232.)

720. WOODS, K. R., and ARMSTRONG, W. D. Action of parathyroid extracts on stable bone mineral using radiocalcium as tracer. *Soc. Expt. Biol. and Med. Proc.* 91: 255-258. 1956.

"The effect of parathyroid hormone injections causing mobilization of Ca^{45} from incarceration in stable bone mineral of rats was studied by observing specific activities of bones and amts. of Ca^{45} appearing in the urine before and after subcutaneous injections of bovine parathyroid exts. From the greatly increased renal excretion of Ca^{45} following injection of the exts. it is concluded that these exts. are able to induce mobilization of stable bone material from the rat skeleton." (Chem. Abs. 50: 7988.)

Estrogens, Cortisone, and Other Steroids

721. ABITBOL, V., PIETTE, M., and ASCHKENASY, A. Effects of adrenalectomy and repeated injections of ACTH, cortisone and prednisone on the alkaline phosphatases of the bone and bone marrow in rats. *Soc. de Biol. [Paris] Compt. Rend.* 150: 1381-1383. 1956.

722. BAISET, A., and others. The action of thyroxine and estrogens on ossification. *Jour. de Physiol.* 46: 731-744. 1954.

L. Douste-Blazy, P. Montastruc, and H. Planel, joint authors.

"Rats were treated with thyroxine (I), estradiol benzoate (II), or I and II, and the mech., radiological, histological, and biochem. properties of their connective cartilage (III) and bony tissue (IV) examd. Either I or II leads to atrophy of III and causes the appearance of a metaphyseal calcification band. Mechanically, the strength of III is increased. In IV, I, and II have opposing actions: I causes atrophy of the osteoid spicules and decreases the amt.

of N and Ca, which lead to a rarification and weakening of the diaphysis of the IV. II causes a widening of the bony components, increases the N content, but does not affect Ca deposition; the strength of the diaphysis is not affected." (Chem. Abs. 49: 7091.)

723. BUDY, A. M. Osteogenic properties of estrogenic hormones. *N.Y. Acad. Sci. Ann.* 64: 428-431. 1956.

724. CHAMBON, Y. The effect of estrogens on calcium metabolism. *Semaine Hôp.* 31: 1440-1441. 1955. "A short review on the systemic effect of estrogens in birds; 20 references." (Chem. Abs. 49: 16137.)

725. CHAMBON, Y., and MICHOU, J. Action of various vascular active drugs on bone tissue and blood calcium when administered by intraosseous injection in male ducks. *Soc. de Biol. [Paris] Compt. Rend.* 148: 459-462. 1954.

Injections were made on alternate days for 2 weeks into the bulb of the tibia in adult drakes. Acetylcholine chloride (10-25 mg. per injection) caused neoformation of bone in the marrow cavity and a small decrease in blood Ca. (It had no such effect when injected subcutaneously.) Yohimbine-HCl (1-5 mg.) caused neoformation of bone and a 14 percent decrease in blood Ca. Atropine sulfate (0.05-0.2 mg.) had a slight and irregular effect or perhaps no effect. Ephedrine-HCl (5-20 mg.) caused no neoformation of bone but caused rarefaction of existing bone and a 14-23 percent increase in blood Ca.

726. CHAMBON, Y., and MICHOU, J. Osteogenic and hypocalcemic action of estradiol and histamine administered by intraosseous injection in male ducks. *Soc. de Biol. [Paris] Compt. Rend.* 148: 342-345. 1954.

Previous findings are confirmed that estradiol or histamine injected into a bone results in neoformation of bone in the marrow cavity and transient decrease in blood Ca.

727. CLARK, I., and GEOFFROY, R. F. Adrenal steroids and calcium metabolism in the rat. *Fed. Proc.* 16: 165. 1957.

"A marked increase in urinary excretion of radiocalcium was observed after the injection of a single subcutaneous dose of 11-oxygenated steroids 48 hours after the administration of radiocalcium. This increase began at about the third hour and was maintained until the eighth hour, after which the values fell to the level of the control animals. Daily injections of these steroids 50 days after the injection of radioactive calcium again resulted in an increased urinary excretion of radiocalcium. In these experiments the increased excretion of radiocalcium was not evident until the third or fourth day, and this increase was augmented as long as the steroid was administered. The effectiveness of the steroids in increasing radiocalcium excretion paralleled their clinical and biological behavior in most instances, i.e., prednisolone > prednisone > hydrocortisone > cortisone. Pretreatment of adult male rats with hydrocortisone for 2-3 months resulted in an increased urinary excretion and in a decreased bone uptake of radiocalcium as compared with control rats also fed ad libitum. A decreased uptake of radiocalcium by bone was also observed in similar groups of rats, which were nephrectomized immediately prior to the injection of radiocalcium." (Author's abstract.)

728. COFER, E. S., PORTER, T., and DAVIS, M. E. The effect of withdrawal of estrogens on the nitrogen, calcium and phosphorus balances of women. *Jour. Nutr.* 61: 357-372. 1957.

"The effect of withdrawal of diethylstilbestrol therapy in 2 oophorectomized subjects and of oophorectomy in 1 subject on the N, Ca, P balances and on the urinary 17-keto steroid, pregnanediol, and corticoid excretions was investigated. Withdrawal of estrogenic influences may have been responsible for observed increased N loss and Ca output." (Chem. Abs. 51: 13193.)

729. DZIEWIATKOWSKI, D. D., and others. Some aspects of the metabolism of sulfate- S^{35} and calcium-45 in

he metaphyses of immature rats. Influence of β -estradiol benzoate. Jour. Biophys. and Biochem. Cytol. 3: 151-160. 1957.

F. Bronner, N. Di Ferrante, and R. M. Archibald, joint authors.

"Rats at the age of 21 days received injections of 2 mg. of 17 β -estradiol benzoate (I) weekly for 4 consecutive weeks. Twenty-four hours after each injection, one group was injected with $\text{Na}_2\text{S}^{35}\text{O}_4$ and another with $\text{Ca}^{45}\text{Cl}_2$. The animals were sacrificed 24 hours after the last injection of the isotopes. The concn. of Ca^{45} in the proximal ends of tibiae and humeri, in the distal ends of the humeri, and in the parietal bones of the I-treated rats was slightly higher than in those of the untreated rats. No difference was found in the serum, skin, and middle humerus. Increases were observed in the S^{35} concn. in treated rats in the tissues examd. Alk. extn. of the distal metaphyses of the femurs removed 44% of the S^{35} and 63% from treated and control rats, resp. Chromatographic analyses of exts., on an anion-exchange resin, showed that 9-22% of S^{35} was inorg. sulfate. Decalcification of bone samples with Na versenate removed 6-21% of the S^{35} . Most of the remaining S^{35} was assocd. with uronic acid and hexosamine. Analyses of solns. contg. the org. S^{35} by paper chromatography and electrophoresis indicated that this fraction behaved in the same manner as purified chondroitin sulfate (II). No striking changes were found in the alkaline phosphatase activity of the serums and humeri following treatment with I. Autoradiograms of the proximal ends of tibiae from I-treated rats showed that S^{35} and Ca^{45} were deposited in the metaphyses in strata, but each isotope was arranged differently. This difference was interpreted to indicate that most of the S was derived from II." (Chem. Abs. 51: 16926.)

730. EDGREN, R. A., and CALHOUN, D. W. Density as an index of the effects of estrogens on bone. Endocrinology 59: 631-636. 1956.

"Estrone, estradiol, and diethylstilbestrol, decreasing in that order, stimulated femoral d. increases in mice, presumably by causing proliferation of medullary bone." (Chem. Abs. 51: 2976.)

731. FISCHER, F., and HASTRUP, B. Cortisone and calcium balance (effect of calcium, vitamin-D and methylandrostenediol). Acta Endocrinol. 16: 141-148. 1954.

"The study was carried out in a young male patient suffering from severe ankylosing spondylitis associated with peripheral joint involvement. He was confined to bed before and during the whole experimental period and received a Ca-poor standard diet containing 160 mg. Ca per 24 hr. The cortisone dose was 100 mg. daily with exception of control periods at the beginning and the end of the study, which lasted for 164 days. (1) While receiving the Ca-poor diet cortisone caused an increasing negative Ca balance. (2) Addition of Ca (1 g. daily) as phosphate and vit. D (5,000 I.U. daily) temporarily reverted the balance to positive after which it again became slightly negative. (3) Administration of methylandrostenediol (100 mg. daily) reduced the excretion of Ca in the urine as well as in the faeces and made the balance positive. (4) Marked retention of Ca occurred on reduction and discontinuation of the cortisone administration.

No untoward effects were seen from the administration of Ca, vit. D and methylandrostenediol in the dosages mentioned for 4, 4, and 1 months, respectively. To counteract the potential osteoporosis it thus seems rational to give patients with Cushing's syndrome and patients under long-term treatment with ACTH or cortisone an abundant amount of Ca and vit. D, and—at least periodically—addition of methylandrostenediol." (Excerpta Med. 8: 4917.)

732. GOVAERTS, J., DALLEMAGNE, M. J., and MELON, J. Radiocalcium as an indicator in the study of the action of estradiol on calcium metabolism. Endocrinology 48: 443-452. 1951.

"In pigeons daily injection of estradiol increased Ca metabolism. The overall retention of Ca was increased.

The biol. half life of Ca was prolonged to 75 days from the av. normal of 45 days. The new medullary bone of the femur and tibia was very rich in the injected radioactive Ca." (Chem. Abs. 47: 1806.)

733. KEITEL, H. G., and BLAKELY, J. The concentration in plasma of potassium and calcium during testosterone medication. Jour. Lab. and Clin. Med. 49: 96-99. 1957.

"Ten undersized children were given 75-100 mg. of methyltestosterone/day for 30 days and a 6-15% increase in body wt. occurred. Repetitive analyses of plasma K and Ca failed to show a change in the concn., in contrast to the report of Butler, *et al.*" (Chem. Abs. 51: 6000.)

734. LAYANI, F., and others. Experimental study of cortico-adrenal control of the alkaline phosphatase activity of bone and bone marrow; ACTH-heparin antagonism. Presse Méd. [Paris] 64: 1681-1682. 1956.

A. Aschkenasy, M. Piette, and V. Abitbol, joint authors.

"The bone and the marrow of ground rat femurs, suspended in water was autolyzed at 4° for 24 hrs. and the phosphatase activity (I) of each was detd. by the King, *et al.*, method (C.A. 36, 45366). In controls the I was, resp., 2.8 (± 0.3) and 27.8 (± 1.4) mg. phenol/g. fresh tissue; adrenalectomized animals had a I of 3.2 (± 0.4) and 45.0 (± 5.2). In rats receiving 2.5 mg./day of ACTH for a week I was 3.3 (± 0.5) and 28.3 (± 3.7); after similar treatment with 0.5 mg./day of heparin added I was 3.4 (± 0.7) and 30.8 (± 5.5) and after heparin alone 2.6 (± 0.3) and 30.9 (± 5.2). In another lot of animals controls had a I of 9.0 (± 1.1) and 74.3 (± 9.3). ACTH 5 mg./day for a week lowered these values to 5.9 (± 0.7) and 35.0 (± 3.1), resp.; the same doses of cortisone decreased them to 4.1 (± 0.3) and 15.4 (± 3.0) and delta-cortisone inhibited the I, down to 2.8 and 13.2 mg. phenol/g. fresh tissue. In a 3rd lot the rats received 1 injection of 5 mg. of ACTH which decreased their I as much as a week's treatment." (Chem. Abs. 51: 7529.)

735. LICHTWITZ, A., and CLEMENT, D. Estrogens and phospho-calcium metabolism. Semaine Hôp. 31: 983-986. 1955.

736. LICHTWITZ, A., and others. Le métabolisme du calcium et les stéroïdes. Semaine Hôp. 31: 554-562. 1955.

D. Clement, R. Parlier, and M. Delaville, joint authors.

737. LOTZ, W. E., and COMAR, C. L. Influence of alpha estradiol on skeletal tissue and radiocalcium metabolism of castrated male lambs. Fed. Proc. 17: 100. 1958.

"The daily administration of 0.1-2.5 mg. levels of alpha estradiol to 26 castrate lambs for periods of 37-171 days resulted in an increased amount of medullary bone in the femur. The increased amount of bone was proportional to the dose of the estrogenic hormone and to the length of administration and apparently resulted from the action of two separate processes: (1) an increased amount of bone of endosteal origin lining the shaft of the femur (caused either by a stimulation of bone formation or an inhibition of normal bone resorption or both) and (2) an increase in bone endochondral origin in the femur metaphysis (caused by an interference with normal resorption of the trabeculae). Autoradiograms failed to show a difference in the amount of in vivo or in vitro uptake of radiocalcium between the bones of control and estrogen-treated animals. This led to the conclusion that an increase in the rate of calcification could not have accounted for the increased formation of the medullary bone. Additional support for the conclusion that an increased rate of calcification of bone did not result from estrogen administration was found in a lack of difference between the rates of disappearance of radiocalcium from the blood of control and estrogen-treated lambs." (Author's abstract.)

738. MACKAY, I. R., and VOLWILER, W. Effect of cortisone upon absorption of protein, fat, and calcium

in idiopathic steatorrhea. *Gastroenterology* 28: 972-980. 1955.

"The case history of a young female with severe idiopathic steatorrhea is described. Metabolic balances for fat, N and Ca, and intestinal absorption tests were studied before and during emergency ACTH and cortisone therapy. Dramatic clinical response was paralleled by a rapid fall in daily stool wt. and prompt improvement in fat, N, and Ca absorption. Ca balance data suggest that very large doses of oral vitamin D may be ineffective in relapses of sprue and that cortisone may promote Ca absorption independently of the action of vitamin D." (*Internatl. Abs. Biol. Sci.* 4: 459.)

739. MANDEL, P., EBEL-GRIES, A., and FONTAINE, R. Effect of testosterone on calcium balance in castrated male rats. *Soc. de Biol. [Paris] Compt. Rend.* 148: 713-715. 1954.

"Castration causes the adult male rat to show a neg. Ca balance; administration of testosterone restores the Ca balance to normal. In all cases the urinary excretion of Ca is unchanged, while the fecal excretion is altered." (*Chem. Abs.* 49: 4630.)

740. MANDEL, P., and others. Composition of bones in growing rats subjected to action of cortisone. *Soc. de Biol. [Paris] Compt. Rend.* 147: 511-514. 1953.

R. Fontaine, A. Ebel-Gries, and A. Voegelisen, joint authors.

"Daily injection of cortisone retarded or arrested body growth, retarded growth of the leg bones, and decreased bone phosphatase activity. Mineralization of the bones was not affected." (*Chem. Abs.* 48: 2239.)

741. MANUNTA, G. Influence of estrogens on the calcium content of urine. *Studi Sassaresi* 33: 346-351. 1955.

"In both male and female gonadectomized rats fed a diet of sucrose and distd. water the administration of a synthetic estrogen caused a transient decrease of urinary Ca." (*Chem. Abs.* 50: 2803.)

742. MANUNTA, G., SAROFF, J., and TURNER, C. W. Metabolism of Ca^{45} in blood, bones and young of lactating rats treated with estradiol. *Soc. Expt. Biol. and Med. Proc.* 94: 788-789. 1957.

"Estrogen, in an amount estimated to equal that secreted in late pregnancy, was injected daily into lactating rats for 4 days along with Ca^{45} . On the fifth day radioactivity of blood serum, bones, and young was compared to that of a similar group of lactating rats not treated with estrogen. Average gain in weight of the litters of the two groups was similar. However, radioactivity in the serum and bones of the treated group was significantly higher than in the controls. The radioactivity in litters of the two groups was similar. These data indicate that estrogen plays a role in the retention of calcium by the animal body." (Author's summary.)

743. MARTIN, E., and MAJNO, G. Cortisone and osseous tissue. *Schweiz. Med. Wchnschr.* 84: 757-760. 1954.

"A histological study was made of bone development in the mouse. Administration of estradiol benzoate provoked osteogenesis which could be partially inhibited by cortisone." (*Chem. Abs.* 48: 12266.)

744. NUTLAY, A. G., and others. Effects of estrogen on the gingiva and alveolar bone of molars in rats and mice. *Jour. Dent. Res.* 33: 115-127. 1954.

S. N. Bhaskar, J. P. Weinmann, and A. M. Budy, joint authors.

"Newborn rats which received subcutaneously a total of 0.05-1.30 mg. α -estradiol benzoate showed no significant changes in the development or the structure of the molars, the supporting structures of the teeth, the size of the bone-marrow spaces, the type of marrow, or the epithelial attachment. Newborn mice which received subcutaneously 0.20 mg. diethylstilbestrol or α -estradiol benzoate

in olive oil showed no significant changes; those which received a total dose of 0.80-1.30 mg. of either compd. in 25 or more days showed changes in bone marrow (replacement of hemopoietic marrow of alveolar process by fibrous marrow), supporting bone, and periodontal membrane. Old mice (1 yr. old) which received either a subcutaneous implant of 2.0 mg. cryst. α -estradiol benzoate or a subcutaneous total dose of 1.5-6.0 mg. of that compd. in olive oil in weekly doses of 0.5 mg. developed gross and histological changes of the teeth and their adjacent structures." (*Chem. Abs.* 48: 5971.)

745. RIGAMONTI, L. Influence of testosterone on the serum levels of sodium, potassium, and calcium. *Arch. per le Sci. Med.* 104: 317-327. 1957.

"Dogs were treated intravenously or intramuscularly with testosterone. The Ca in the serum was not affected, the Na increased, and the K decreased. The mode of administration influenced the time of onset and the duration of the effect." (*Chem. Abs.* 52: 2269.)

746. ROSSOTTO, P., and others. In vitro effects of androgen hormones and of estrogens on some reactions of the citric acid cycle on bone tissue. *Minerva Chir.* 12: 952-953. 1957.

A. Ruffo, F. Badellino, and G. Massa, joint authors. "The influence of addn. of testosterone and/or estradiol on the citric acid synthesis and dehydrogenation, and on the succinic dehydrogenase activity of bone tissue *in vitro* was studied. It was observed that only estradiol (benzoate) inhibits the 3 above activities." (*Chem. Abs.* 52: 2224.)

747. SCHJEIDE, O. A., and URIST, M. R. Proteins and calcium in serums of estrogen-treated roosters. *Science* 124: 1242-1244. 1956.

"Roosters were injected intramuscularly with estrone. Serum chylomicrons and β -lipoproteins increased, α -lipoproteins almost disappeared, and two new components, X_1 and X_2 appeared. Studies with the ultracentrifuge indicated that X_1 is a phosphoprotein which complexes most of the elevated serum Ca. The component X_2 is a dense lipoprotein, which coppts. X_1 when the salt concn. of the serum is reduced by diln. The bound Ca is then released. The sedimentation rates of X_1 and X_2 (S 7.5 and S 15.0, resp.) and other properties are similar to those of 2 components of hen-yolk vitellin (cf. *Growth* 19: 297 (1955)), one of which seems to be identical with livetin. The authors suggest that the elevated Caphosphoprotein-lipoprotein system of the serum provides a mechanism of deposition of storage nutrients (vitellin) in the egg yolk for the embryo." (*Chem. Abs.* 51: 6728.)

748. SELYE, H., and BOIS, P. Corticoids on resistance of kidney to excess of phosphates. *Amer. Jour. Physiol.* 187: 41-44. 1956.

"In unilaterally nephrectomized rats, the substitution of 1.2% NaH_2PO_4 for drinking water rapidly produced marked Ca deposition in the pars intermedia of the kidney. This effect on the PO_4 solution is enhanced by concurrent treatment with DOCA and inhibited by cortisol acetate. The possible role of corticoids in the production of clinical nephrocalcinosis and renal calculus formation is briefly discussed." (*Internatl. Abs. Biol. Sci.* 6: 2097.)

749. URIST, M. R., BUDY, A. M., and McLEAN, F. C. Species differences in the reaction of the mammalian skeleton to estrogens. *Soc. Expt. Biol. and Med. Proc.* 68: 324-326. 1948.

"Estrogenic steroid hormones stimulate endosteal bone formation and inhibit bone resorption in mice. In young growing rats the same substances do not produce endosteal bone but interfere with endochondral ossification by inhibiting resorption of cartilage matrix and new bone. In other rodents, such as hamsters, guinea pigs and rabbits, and also in cats and dogs, there is no apparent specific effect of estrogens upon formation of bone." (Author's summary.)

750. URIST, M. R., BUDY, A. M., and McLEAN, F. C. Endosteal-bone formation in estrogen-treated mice. *Jour. Bone and Joint Surg.* 32A: 143-162. 1950.

"Newborn mice, treated with estrogen from the date of birth, showed microscopic evidence of bone changes within 10 days, although no gross or roentgenographic changes were demonstrable until after 20 days of treatment. The skeletons of embryos of treated mothers showed no endosteal bone in roentgenograms. Mice from 1 to 6 months of age showed no appreciable differences in their response to estrogens. Aged mice, 1 year or older, showed some delay in the response, and the volume of endosteal bone was less than in similarly treated young mice. There was no variation in the bone reaction in the different hereditary strains studied. The volume of new bone deposited was, within the limits of the tolerance of the animal, directly proportional to the dose and the period of administration. Mice treated with 2.0 mg. of α -estradiol benzoate over a period of 4 weeks recovered from the effects of estrogen after treatment was discontinued. Normal endochondral ossification reappeared below the epiphyseal lines within 6 weeks. The endosteal bone was almost completely absorbed within 18 weeks. The serum calcium, inorganic phosphorus, and alkaline phosphatase were within the range of normal levels during administration of estrogen and endosteal new bone formation. Esterification of an estrogen was one of the most important factors in its osteogenetic potency. Endosteal new bone formation was not induced by luteal, corticoid, or testoid hormones. There was neither inhibitory nor synergistic action of progesterone, desoxycorticosterone acetate, or testosterone propionate on the osteogenetic action of estrogens. Osteogenetic action of estrogen was neither enhanced nor inhibited by simultaneous treatment of the animals with preparations of anterior pituitary hormone. Adrenocorticotrophic hormone induced no endosteal new bone formation. No evidence was found that the mouse produces endosteal new bone, characteristic of the effects of estrogens, under strictly physiological conditions. During pregnancy, when large amounts of estrogen were being excreted in the urine, neither the fetal nor the maternal skeleton showed roentgenographic evidence of estrogen-induced bone formation. No production of endosteal bone was observed in either immature or mature mice in which the ovaries were under the influence of large doses of gonadotropic hormones administered over a long period of time." (Excerpt from author's summary.)

Thyroid Hormone

751. BAVETTA, L. A., BERNICK, S., and ERSHOFF, B. Influence of dietary thyroid on bones and periodontium of rats on total and partial tryptophan deficiencies. *Jour. Dent. Res.* 36: 13-20. 1957.

"The results of partial or complete tryptophan deficiency were made worse by the addition of dietary thyroid. These included changes in the epiphyseal plates of long bones, and osteoporosis of alveolar bone. Growth was also depressed. Ulceration of the gingival epithelium occurred when rats receiving diets low in tryptophan content were fed dietary thyroid. These changes were not noted in the absence of the additional hormone." (*Internatl. Abs. Biol. Sci.* 7: 163.)

752a. DE BASTIANI, G., SPERTI, L., and ZATTI, P. Effects of thyrotropic hormone on chondrogenesis and osteogenesis in the guinea pig. *Bol. della Soc. Ital. di Biol. Sper.* 32: 1233-1236. 1956.

752b. FENG, Y. S. L., and WASE, A. W. Sialoadenectomy and the metabolism of calcium in bone and soft tissues of mouse. *Fed. Proc.* 16: 179. 1957.

"Sialoadenectomy has been reported to reduce the total ash, Mg, and P of the bones of rats. Extracts from salivary glands, when administered to animals, reduce plasma calcium. Sialoadenectomized mice were prepared and treated as described previously. Radiocalcium was administered i.p. The Ca^{45} content of tissues was deter-

mined 2 hours after administration. Radioassay was performed with the aid of a gas-flow counter and counting was extended in time to give a 2 percent statistical error. The Ca^{45} incorporation into bone and nearly all other soft tissues was greatest in the sialoadenectomized mice. It suggests that the animals were depleted in calcium. A calcium-balance study showed that a reduced intake by the sialex mice, a higher fecal output, and a lower urinary output indicate that the absorption of dietary calcium was decreased. The reduced urinary excretion was investigated with Ca^{45} and found to be 38 percent of control values in a 24-hour test. A 2-hour uptake of Sr^{90} showed that the sialex animal's femur was 175 percent of control values. It suggests interference with the absorption of calcium from the digestive tract. Other interrelations are discussed." (Author's abstract.)

753. KRANF, S. M., and others. The effect of thyroid disease on calcium metabolism in man. *Jour. Clin. Invest.* 35: 874-887. 1956.

G. L. Brownell, J. B. Stanbury, and H. Corrigan, joint authors.

" Ca^{45} and the method of isotope dilution were used to compare Ca metabolism in patients with thyroid disorders, in control subjects with coronary heart disease and Friedreich's ataxia, and in patients with Paget's disease (osteitis deformans) and hypoparathyroidism. In 4 subjects with hyperthyroidism, specific activity of serum and urine declined more rapidly and to lower levels than in controls. Two patients with myxoedema showed the least fall in specific activity, but after treatment specific activity declined at the same rate as in the controls. In Paget's disease the initial rapid fall in specific activity was more prolonged than in hyperthyroidism. The data are analysed and discussed in terms of Ca pool, size of Ca compartments and rate of flow of Ca to and from these compartments. Ca, P, and N metabolic balance data and serum Ca, P, alkaline phosphatase and protein-bound I values are tabulated. In myxoedema of long standing, subjects were slightly negative Ca balance. Urinary Ca excretion was low and increased after treatment. Two of the 4 hyperthyroid patients had normal urinary Ca values and were only in slightly negative Ca balance. The other 2 had high levels of Ca in faeces as well as in urine and were in distinctly negative Ca and P balance, but were nearly in N equilibrium. This is inconsistent with the view that high urinary Ca of hyperthyroidism is directly related to N losses. The findings suggest that bone formation as well as destruction are proceeding at increased rates in thyrotoxicosis." (*Nutr. Abs. and Rev.* 27: 689.)

754. WALKER, D. G. An assay on the skeletogenic effect of L-triiodothyronine and its acetic acid analogue in immature rats. *Johns Hopkins Hosp. Bul.* 101:101-114. 1957.

755. WASE, A. W., and FENG, Y. S. L. Sialoadenectomy and the metabolism of calcium-45 in bone and soft tissues of the mouse. *Nature* 178: 1229-1230. 1956.

" Ca^{45} incorporation into bone and nearly all soft tissues (lung and thymus excepted) was increased in sialoadenectomized mice. The bones concd. Ca^{45} 1.64 times more than did intact controls, liver 1.44, kidney 1.20, brain 1.31, spleen 1.36, heart 1.30, lung 0.87, muscle 1.23, thymus 0.68, thyroid 1.39, adrenal 1.21, testes 1.56. It is suggested that sialoadenectomy causes a decreased absorption of Ca from the digestive tract and inhibits thyroid activity in a manner involving the hypophysis." (*Chem. Abs.* 51: 5965.)

756. WASE, A. W., and FENG, Y. S. L. Sialoadenectomy and thyroid response to thyrotrophic hormone. *Nature* 178: 1395-1396. 1956.

"The uptake of P^{32} (2 hr. after injection of PO_4) by rat thyroid glands was measured, after treatment with TSH in intact rats, in sialoadenectomized hypophysectomized and hypophysectomized-sialoadenectomized rats. The results obtained suggest the salivary gland secretions have some regulatory control on thyroid activity, probably

involving the control of the action of TSH on thyroid tissue. The role of the hypophysis appears to be dominant." (Internatl. Abs. Biol. Sci. 7: 2583.)

757. WASE, A. W., and FENG, Y. S. L. Some salivary-thyroid gland relationships. *Acta Endocrinol.* 23: 413-418. 1956.

"Mouse and rat salivary glands modify thyroid activity to an appreciable extent. The reduced P^{32} activity of the thyroids of sialoadenectomized animals indicated (i) that the effective titre of TSH was reduced in these animals, or (ii) that its function in the regulation of thyroid activity had been impaired. Since the inhibin produced was proportional to the amount of salivary gland removed it can be assumed that if a single substance is responsible for the effect, it must be uniformly distributed or produced throughout the glands. Also, the rapid appearance of the inhibin following sialoadenectomy indicates a direct relationship. The absence of change in thyroid activity in hypophysectomized-sialoadenectomized animals suggests that the action of the salivary glands on thyroid activity may be in conjunction with or directly upon the pituitary." (Internatl. Abs. Biol. Sci. 7: 4997.)

Hypophyseal and Other Hormones

758. CICARDO, V. H., and MURACCIOLE, J. C. Metabolism of radioactive calcium in normal and hypophysectomized toads. *Rev. de la Soc. Argentina de Biol.* 30: 169-175. 1954.

"Two hrs. after injection of $Ca^{45}Cl_2$ into *Bufo arenarum* there was evident fixation of Ca^{45} in the bones. Highest values were found 24 hrs. after the injection and some Ca^{45} was still present in the bones after 45 days. The heart muscle, lungs, and kidney tissue took up no significant amt. of Ca^{45} . The digestive tract and feces showed intense radioactivity. The excretion of Ca^{45} began about 24 hrs. after the injection and was mainly via the feces, with a small proportion in the glandular area of the skin and still less in the urine. Hypophysectomized toads fixed as much injected Ca as normal toads; elimination in the feces was slower and elimination through the skin and kidneys was faster than in the intact toads." (Chem. Abs. 49: 12735.)

759. IRVING, J. T. Action of the hypophysis and of dietary protein on the calcifying tissues. *Nature* 178: 1231. 1956.

760. LOSTROH, A. J., and LI, C. H. Bioassay of hypophyseal growth hormone in hypophysectomized mice by the tibia test. *Endocrinology* 60: 308-317. 1957.

"BALB/C, A/He, C3H, and C57BL mice have been tested to discover the most suitable strain for growth hormone assay using the tibial proximal epiphyseal cartilage width as the quant. index of hormone activity. The first 3 strains mentioned gave comparable responses which were greater than the response of the C57BL mice. A 17-day test (daily injections of growth hormone) was 10 times more sensitive than a 4-day test. The sensitivity of the latter, however, was greatly enhanced by a small dose of thyroxine." (Internatl. Abs. Biol. Sci. 8: 2028.)

761. MARX, W., and REINHARDT, W. O. Lack of effect of growth hormone on deposition of radiostrotrium in bone. *Soc. Expt. Biol. and Med. Proc.* 51: 112-114. 1942.

762. MURPHY, W. R., DAUGHADAY, W. H., and HARTNETT, C. Effect of hypophysectomy and growth hormone on the incorporation of labelled sulphate into tibial epiphyseal and nasal cartilage of the rat. *Jour. Lab. and Clin. Med.* 47: 715-722. 1956.

"The ability of the tibial epiphyseal cartilage to incorporate (S^{35}) sulphate falls after hypophysectomy. Growth hormone stimulates the uptake of sulphate in both epiphyseal and nasal cartilages. The response of the tibial epiphysis is proportional to the log of the total dose of growth hormone between 10 and 250 μ g. given during the 24 hr.

prior to the administration of the labelled sulphate. The effect of growth hormone on sulphate uptake can be used as an assay procedure for growth hormone. This action of growth hormone on increasing sulphate uptake is not entirely sp. Thyroxine also increases the incorporation of sulphate, and TSH also augments the action of growth hormone. Cortisone and hydrocortisone inhibit the uptake of sulphate by normal rats." (Internatl. Abs. Biol. Sci. 7: 3604.)

763. PINDBORG, J. J., BECKS, H., and EVANS, H. M. Ossification of the proximal end of the femur in female rats. I. Changes with increasing age. II. Changes following hypophysectomy. III. Changes following injections of growth hormone, thyroxine, and their combinations. *Acta Endocrinol.* 26: 142-152. 1957.

"One center of ossification in the greater trochanter was established on the 26th day, another one in the head of the femur between 42 and 253 days. The first sign of sealing-off of the disk on the femur head was seen at 76 days of age. Finally the disk disappeared, establishing a bone union between epiphysis and diaphysis. Hypophysectomy delayed the establishment of the 2nd ossification center. Growth hormone restored the chondrogenic and osteogenic processes in the dormant epiphyseal disk of hypophysectomized rats. Injection of thyroxine caused only slight changes toward reactivation of chondrogenesis and osteogenesis. Combining thyroxine and growth hormone was only occasionally slightly more effective than growth hormone alone." (Chem. Abs. 52: 1407.)

764. RUFFO, A. Radioactive strontium uptake by the skeletal system after bilateral adrenalectomy and hypophysectomy. *Minerva Chir.* 12: 876-880. 1957.

"In adrenalectomized or hypophysectomized rats subcutaneously injected with 8 microcuries Sr^{124} (as the chloride)/100 g. body wt., the Sr^{124} uptake (radioactivity detns. in 12 sections of the skeletal app.) was much lower (even below 50%) than in normal rats." (Chem. Abs. 51: 18219.)

765. RUFFO, A., and others. Radioactive phosphorus absorption by the skeletal system after hypophysectomy. *Minerva Chir.* 12: 322-324. 1957.

P. Rossotto, U. Marinoni, F. Badellino, and E. Signorelli, joint authors.

"Comparative expts. on hypophysectomized vs. normal rats showed the P^{32} (given as $H_3P^{32}O_4$ in HCl, pH 3, intraperitoneally) uptake by the various skeleton sections, to drop by 50-75% following the operation." (Chem. Abs. 51: 16808.)

766. SELYE, H. Skeletal lesions produced by chronic treatment with somatotrophic hormone (STH) and amino-acetonitrile (AAN). *Jour. Gerontol.* 12: 270-278. 1957.

767. SILBERBERG, R., and SILBERBERG, M. Changes in bones and joints of underfed rats bearing anterior pituitary grafts. *Endocrinology* 60: 67-75. 1957.

"Epiphyseal development and the incidence of degenerative lesions in the joints of A mice were reduced when they were underfed. These changes were reversed if the mice bore ant. pituitary grafts though the effects of these were less than in fully fed mice." (Internatl. Abs. Biol. Sci. 7: 4640.)

GESTATION AND LACTATION

768. ALBRIGHT, J. L., and BLOSSER, T. H. Blood levels and urinary excretions of calcium in normal cows and cows with parturient paresis after intravenous injections with calcium borogluconate. *Jour. Dairy Sci.* 40: 477-486. 1957.

"Fourteen cows with milk fever, five normally calving mature cows, and three normally calving primiparous heifers were injected with either a 32.7 or a 25.5% calcium borogluconate soln. Although the cows injected with the more highly concd. soln. responded initially with higher blood serum Ca levels, by 4-10 hr. post-injection there

was little difference in blood serum Ca levels between cows receiving the 32.7% and those receiving the 25.5% soln. Fifty percent relapses occurred in the milk-fever cows following treatment with each soln. In addn., two of three normal parturient cows injected with the 32.7% soln. developed milk fever 35 hours post-injection. From these data it appears that, (a) there is no advantage in treating milk-fever cows with a highly concd. Ca borogluconate soln. and (b) injection of a highly concd. Ca borogluconate soln. 12 hrs. post-calving does not prevent milk fever and may actually precipitate attacks. The data show little, if any, relations between urinary excretion of Ca following injection of Ca borogluconate and subsequent lowered levels of blood serum Ca and relapses into the milk-fever syndrome. The three groups of cows (milk-fever, normal parturient, and primiparous) responded in essentially the same way to injection of Ca solns. Primiparous animals exhibited higher blood serum Ca levels at the end of a 24-hr. post-injection period than cows in the other groups." (Chem. Abs. 52: 3144.)

769. ATEN, A. H. W., JR., and HEYN, C. B. Secretion of radio-calcium in milk. *Amer. Jour. Physiol.* 162: 579-580. 1950.

"The secretion of radioactive Ca in milk was measured in a goat after the subcutaneous injection of radioactive calcium. The activity of calcium ions in the milk increased rapidly during the first hours after injection." (Author's summary.)

770. BLOSSER, T. H., and ALBRIGHT, J. L. Urinary calcium excretion of blood calcium levels in the bovine near the time of parturition. *N.Y. Acad. Sci. Ann.* 64: 386-397. 1956.

"A review with 42 references." (Chem. Abs. 51: 9858.)

771. BLOSSER, T. H., and WARD, G. M. Blood levels and urinary excretion of citric acid at parturition. *Amer. Dairy Sci. Assoc. Ann. Meeting West. Div. Proc.* 35: 35-44. 1954.

"Fourteen dairy cows were divided into 4 groups by breed, age, and normalcy of calving in order to study some of the changes in blood levels and urinary excretion of citric acid at parturition and in milk fever. Blood and urine samples were collected from 30 days before to 30 days subsequent to calving. There was a pos. correlation between blood serum and urinary citric acid in all groups of cows. The relation between blood serum Ca and citric acid was less distinct, although 2 of the 4 groups studied showed a pos. relation between these 2 constituents. Blood-serum citric acid declined in all groups at the time of parturition, but the low levels of citric acid persisted for a longer time post-partum in milk fever than in normal cows. First-calf heifers demonstrated a marked rise in blood-serum citric acid in the few days immediately prior to calving. Urinary citric acid followed the same general trend in all groups, declining to a low point at the time of or shortly after calving and increasing in the first 10-15 days post-calving. Detailed data on one cow which developed milk fever showed a decrease in citric acid and Ca and an increase in pyruvic acid, lactic acid, and glucose assocd. with parturition and milk fever." (Chem. Abs. 49: 1908.)

772. BODA, J. M., and COLE, H. H. Calcium metabolism with special reference to parturient paresis (milk fever) in dairy cattle: a review. *Jour. Dairy Sci.* 39: 1027-1054. 1956.

"245 references." (Chem. Abs. 50: 14088.)

773. BOELTER, M. D. D., and GREENBERG, D. M. Effect of severe calcium deficiency on pregnancy and lactation in the rat. *Jour. Nutr.* 26: 105-121. 1943.

"Rats reared from weaning time on a synthetic diet contg. only about 10 mg. Ca per 100 g. food failed to mate. After being transferred to the diet low in Ca, fertility was markedly decreased among a group of mothers each of which had borne a previous litter. The mothers and young were subject to the consequences of extreme Ca deficiency as evidenced by their susceptibility to hemorrhages, pros-

tration and paralysis induced by a galvanic stimulus. Pregnancy was not a great drain upon the Ca stores of the mother rat, but lactation definitely reduced the amt. of skeletal Ca. This was shown by a lowering of total body Ca content, serum Ca concn., percentage bone ash and percentage of Ca of bone ash. These changes were magnified by a marked loss in wt. by the mother during lactation as contrasted to a maintenance of body wt. during gestation. Ca-deficient young that were able to survive were almost normal at birth except for a low bone ash and bone Ca content. The deficient mother was able to supply some Ca to the young during the lactation period but not enough to maintain the normal Ca content of the skeletal structures. She was not capable of providing enough milk to allow for the normal growth of her young." (Chem. Abs. 37: 6017.)

774. BZHALAVA, A. N. Phosphorus metabolism of the mammary gland in relation to milk yield and its butterfat content. *Sovet. Zootekh.* 5: 68-76. 1953.

"In the venous blood emanating from the mammary glands the amt. of inorg. P is above and that of the easily hydrolyzed organic P compounds below that in the arterial blood. Inorg. P and P of easily hydrolyzed organic compounds of the blood was smaller during the pasture period than during the period of barn confinement. This quantitative P picture is reversed in the milk. A parallelism was observed between the milk yield and butterfat and the amounts of the two types of P. A relationship between the milk yield and the butterfat content and the arterio-venous differential in the easily hydrolyzed P compounds was noted. In the process of milk formation the P esters, the lipides, and the protein P of the blood are utilized first. The content of P compounds in the two halves of the cows' udder may differ substantially." (Chem. Abs. 50: 5122.)

775. CARLSTRÖM, G. Studies on parturient paresis in dairy cows. II. Determination of calcium ions in bovine serum. *Acta Agr. Scand.* 5: 357-374. 1955.

"Ca ions react with murexide to produce a violet color. The wave length of max. absorption of the color complex becomes progressively lower with increasing amts. of Ca ion. The amt. of Ca ions present in bovine serum can be detd. by reference to a standard curve in which the wave length of max. absorption is plotted against Ca ion concn. Since the color is changed by pH an accurate detn. of pH must be made." (Chem. Abs. 50: 15692.)

776. COID, C. R., and others. Experiments on the metabolism of certain fission products in dairy cows. *Internatl. Jour. Appl. Radiation and Isotopes* 2: 235. 1957.

L. J. Middleton, B. F. Sansom, and H. M. Squire, joint authors.

Dairy cows were fed with separated carrier-free I^{131} , Sr^{90} , Te^{132} , and Ru^{106} . The amounts of these isotopes recovered from the milk, urine, and feces and their rates of secretion and excretion were measured. Estimates were also made of the amounts retained in the body. Nineteen administrations of iodine were made, 12 of strontium, 5 of tellurium, and 1 of ruthenium. Wide variations in the amounts of I^{131} and Sr^{90} secreted into the milk were observed. These were partly due to the variations in milk yield. Similar experiments were carried out with fission products collected from trials of atomic weapons. There was no apparent difference between the metabolism of the fission products from the two sources.

777. COMAR, C. L. Radiocalcium studies in pregnancy. *N.Y. Acad. Sci. Ann.* 65: 281-298. 1956.

"A review with 33 references." (Chem. Abs. 51: 9858.)

778. CONRAD, H. R., HANSARD, S. L., and HIBBS, J. W. Studies on milk fever in dairy cows. V. The effect of massive oral doses of vitamin D on absorption, excretion, retention and blood levels of calcium and phosphorus. *Jour. Dairy Sci.* 39: 1697-1705. 1956.

"Tracer doses of Ca^{45} and P^{32} were used as markers in balance trials and blood studies with mature lactating and nonlactating cattle to evaluate the changes in absorption,

excretion, and retention of these minerals when massive doses of vitamin D were given. These studies show that massive oral doses of vitamin D increased Ca and P absorption from the digestive tract. There was a decrease in endogenous losses accompanied by an increase in net retention, which extended throughout a 7-day period following vitamin D feeding. These changes in the absorption pattern for Ca and P were accompanied by a delayed increase in blood levels of Ca and P. A rise in blood P was observed to precede the rise in blood Ca. The increase in net absorption of total Ca by nonlactating cattle was accompanied by an increase in radio-Ca concn. in the blood. Radio-Ca disappeared from the blood of lactating cows at a faster rate than from nonlactating cows. Vitamin D was without effect on specific activity of milk Ca." (Chem. Abs. 51: 5286.)

779. DUNCOMBE, W. G. Synthesis of lactose *in vitro* by mammary gland slices from lactating rats, guinea-pigs, and sheep. Jour. Dairy Res. 24: 171-173. 1957.

"Radio-active lactose was found when slices of lactating mammary gland from rat, guinea-pig and sheep were incubated with glucose- C^{14} . The results were taken as the first definite evidence of net lactose synthesis in rat and ruminant. The glucose and galactose moieties of lactose from one experiment with rats had about the same activity. Rat mammary tissue incorporated activity into another compound containing glucose and galactose (see Caputto and Trucco, Abst. 2555, Vol. 22) and its net synthesis was shown. In all 3 species when pyruvate- $2-C^{14}$ was the substrate activity was not incorporated into lactose, but it was detected when inactive glucose with pyruvate- $2-C^{14}$ was used." (Nutr. Abs. and Rev. 27: 5360.)

780. EKMAN, L. Metabolism of fission products in ruminants. Nord. Veterinärmed. 10: 245-254. 1958.

"Radiostromium (Sr^{90}) was administered orally to three goats, and the fecal, urinary, and milk excretions during the following 3-4 months were studied. It was found that the milk was contaminated during 4-6 weeks after the administration. The main excretion occurred with the feces. The urinary excretion lasted about 3 weeks longer than the fecal." (Author's summary.)

781. ELLENBERGER, H. B., NEWLANDER, J. A., and JONES, C. H. Variations in the calcium and phosphorus contents of cow milk. Vt. Agr. Expt. Sta. Bul. 556: 3-26. 1950.

"The relations of the Ca and P percentages in the milk to the fat content, the stage of lactation, and the time of year are tabulated. Both Ca and P percentages increased as the fat content of the milk did but at a much slower rate." (Chem. Abs. 45: 1262.)

782. ERF, L. A., and PECHER, C. Secretion of radio-active strontium in milk of two cows following intravenous administration. Soc. Expt. Biol. and Med. Proc. 45: 762-764. 1940.

"After intravenous injection of ^{86}Sr in two Holstein cows, 7.88 and 11% of the Sr appeared in the milk in 4 1/4 days. About 3/4 of these amts. was secreted in the first 36 hrs." (Chem. Abs. 35: 1514.)

783. FEASTER, J. P., and others. Placental transfer of calcium-45 in rat. Jour. Nutr. 58: 399-406. 1956.

S. L. Hansard, J. C. Outler, and G. K. Davis, joint authors.

"Oral Ca^{45} fed to pregnant rats was transferred via the placenta and deposited in the fetus at all stages of gestation studied, from the 14th-22nd day. Fetal uptake of Ca^{45} was very rapid, reflecting progressive mineralization during the development. Part of the Ca taken up by the fetus was derived from the maternal skeleton." (Internatl. Abs. Biol. Sci. 4: 5881.)

784. FERENC, S., and SÁNDOR, K. Effect of pregnancy on calcium, inorganic phosphorus, carotene, and vitamin A content of blood serum in cows. Allat-tenyésztés 5: 117-127. 1956.

"In addition to blood-serum analyses, milk and colostrum were tested for carotene, vitamin A, Ca, and P content and the results are tabulated separately for several cows. The vitamin and P contents showed a decline with time after calving, but Ca sometimes increased. The cows with low Ca and P blood levels at the end of pregnancy and at the time of calving gave colostrum contg. smaller amts. of these constituents." (Chem. Abs. 51: 7527.)

785. FINKEL, M. P. The transmission of radiostrontium and plutonium from mother to offspring in laboratory animals. Physiol. Zool. 20: 405-421. 1947.

"Mice injected with 5.0 or 2.5 μ c./g. of Sr^{90} before conception produced a smaller number of litters than did the controls. Treatment during pregnancy with 10 or 5 μ c./g. of Sr^{90} or 0.06, 0.03, or 0.016 μ c./g. of plutonium increased the percentage of totally stillborn deliveries, as well as the number of stillborn young in viable litters. The mice treated during pregnancy with either Sr^{90} or Pu lived longer, on the average, than did similarly treated nonpregnant female mice. In addition, radiation damage was less severe among the Pu-treated mothers than it was among non-mothers. The amount of Sr^{90} retained by the mothers immediately after parturition was the same as that retained by virgin adult females at comparable time intervals after injection. A portion of the material that would ordinarily have been excreted was lost through the placenta. The percentage of the maternal dose of either Sr^{90} or Pu that was found in the young at birth varied with the injection-delivery interval. The Sr^{90} activity per gram of body weight of the newborn mouse exceeded that of the mother at the time of delivery if parturition occurred within the first 4 days after administration. At the levels studied, the concentration of Pu in the young never exceeded 8 percent of the concentration in the mother. Treatment of the young animals was continued during the period of suckling by the transfer of both Pu and Sr^{90} through the breast milk. Special studies of the transmission through this route of Sr^{90} were conducted by exchanging newborn litters of treated and normal mothers. The initial excretion of Sr^{90} by very young mice was considerably lower than was the initial excretion by adults. The animals treated in utero and before weaning with Sr^{90} showed retardation of growth, malformation of the long bones, anemia, and osteogenic sarcoma. The animals of the Pu series have developed no pathologic conditions to date. There is no indication that fetal and very young tissues are either more or less sensitive to Sr^{90} and to Pu than are adult tissues." (Author's summary.)

786. GREENBAUM, A. L., and SLATER, T. F. Studies on the particulate components of rat mammary gland. I. A method for determining the composition of the retained fluid. Biochem. Jour. 66: 148-155. 1957.

"The lactose content of the retained fluid of rat mammary gland was assumed to be constant for any stage and the content of deoxyribonucleic acid (DNA) was taken as a measure of the amount of tissue present. From regression equations the percentage of lactose in retained fluid was calculated and in turn the percentage of retained fluid in a tissue suspension. The retained fluid from glands during pregnancy (20 days), lactation (10 days) and involution (2 days) contained 1.85, 2.55 and 5.11 g. lactose per 100 g., corresponding to 1.21, 1.98 and 2.35 g. per 100 g. wet weight of gland. Tissue protein increased slowly during pregnancy, very rapidly over the parturition period and slowly during lactation." (Nutr. Abs. and Rev. 27: 5374.)

787. GREENBAUM, A. L., and SLATER, T. F. Studies on the particulate components of rat mammary gland. II. Changes in the levels of the nucleic acids of the mammary glands of rats during pregnancy, lactation and mammary involution. Biochem. Jour. 66: 155-161. 1957.

"Nitrogen in whole mammary gland and in the mitochondria increased through pregnancy and lactation. Ribonucleic acid (RNA) and DNA increased during pregnancy and particularly at parturition. During lactation RNA increased progressively, but DNA remained almost

constant. Both decreased during involution. Mitochondrial RNA increased during pregnancy and up to the third day of lactation and declined at involution." (Nutr. Abs. and Rev. 27: 5374.)

778. GREENBAUM, A. L., and SLATER, T. F. Studies on the particulate components of rat mammary gland. III. The relationship between enzyme activity and particle counts in mammary gland suspension. *Biochem. Jour.* 66: 161-166. 1957.

"Succinic oxidase in suspensions of rat mammary gland increased sharply at parturition and was greatest in the second half of lactation. The activity was apparently located in the mitochondria. The number of large particles per g. tissue rose to a maximum at the end of pregnancy, fell sharply at parturition and remained constant during lactation." (Nutr. Abs. and Rev. 27: 5374.)

779. GROSS, M., WAGER, H. P., and LOVING, M. Calcium metabolism in pregnancy. *Margaret Hague Maternity Hosp. Bul.* 6: 107-112. 1953.

"A brief review of the recent literature on calcium metabolism in pregnancy is presented. Clinical and biochemical studies are reported on a group of 40 clinic patients maintained on various vitamin-mineral dietary supplements." (Author's summary.)

790. ILIN, D. I., and MOSKALEV, Y. I. On the metabolism of caesium, strontium and a mixture of β -emitters in cows. *Jour. Nuclear Energy* 5: 413-420. 1957. (Nuclear Sci. Abs. 12: 1191.)

791. KLEIBER, M., and LUICK, J. R. Calcium and phosphorus transfer in intact dairy cows. *N.Y. Acad. Sci. Ann.* 64: 299-313. 1956.

A review with 18 references.

792. LASSITER, C. A., and others. Effect of various protein levels on milk production, body weight changes, and metabolism of lactating dairy cows. *Mich. Agr. Expt. Sta. Quart. Bul.* 40: 59-64. 1957.

C. F. Huffman, C. W. Duncan, and G. M. Ward, joint authors.

"In a preliminary reversal trial with 9 lactating Holstein cows given 15 lb. timothy hay daily it was found that cows given grain rations with 7.6 or 9.4 per cent crude protein produced less milk than those on a ration with 13.1 per cent. In a second trial it was found that the protein requirement was met by grain rations with 10.3 or 11.9 per cent crude protein given in addition to 15 lb. timothy hay. It was estimated that the cows given crude protein at the level of 10.3 per cent required on average 0.036 lb. digestible crude protein per lb. 4 per cent fat-corrected milk (FCM). As a result it was concluded that Morrison's recommended allowance of 0.041 lb. digestible crude protein per lb. FCM was only 10 to 15 per cent above the cows' actual requirements." (Nutr. Abs. and Rev. 28: 1432.)

793. LEBEDINSKY, A. V., ed. Contributions to study of metabolism of cesium, strontium and beta emitters in cows. U.S.S.R. Min. Health Sci. Com. Med. Radiol. Rpt. Moscow, 1956.

"In cows the amount of resorption from the intestine seems to be 50 percent. This value is obtained on the assumption that the resorbed portion of the cesium is excreted in equal quantities in the urine and in the feces, (17.6 percent each). The probability of this assumption is evidenced by the fact that the urine/feces ration for cesium in cows is approximately equal to unity. It should be remembered that in rats the cesium is completely resorbed from the intestine. About 10 percent of the strontium is absorbed from the intestine (the skeleton contains 1.45 percent, the internal organs 0.14 percent, 0.88 percent is excreted with the milk, and 3.65 percent with the urine). The amount of resorption of the mixture of β -emitters from the intestine is approximately 1 percent (milk, 0.1 percent; urine, 0.5 percent; skeleton, 0.13 and 0.24 percent; other organs, 0.13-0.01 percent; muscles, 0.15 percent.) (Excerpt from author's summary.)

794. LENGEMANN, F. W., and COMAR, C. L. The secretion of the minerals of milk as studied with radioisotopes. A Conference on Radioactive Isotopes in Agriculture, Michigan State University. U.S. Atomic Energy Comm. TID-7512, p. 387-394. 1956.

A brief review of the secretion and metabolism of the following radionuclides in lactation: Ca^{45} , P^{32} , F^{18} , Na^{22} , I^{131} , Sr^{90-90} , Y^{91} , Pa^{333} , and Cs^{137} , with 29 references.

795. LUICK, J. R., BODA, J. M., and KLEIBER, M. Partition of calcium metabolism in dairy cows. *Jour. Nutr.* 61: 597-610. 1957.

"Cows were unable to maintain Ca balance when the dietary Ca/P ratio was less than unity. They responded to changes in Ca or P in the diet by adjusting gain (absorption) and loss (metabolic fecal excretion). The changes in absorption were much greater than in secretion. Cows on low-Ca (high-P) diets utilized dietary Ca less efficiently than cows on higher-Ca diets. This effect may be due to the high-P content of these rations. In other respects the results are in keeping with the concept of Ca homeostasis. The lactating cow utilized dietary Ca more efficiently than the nonlactating cow; the pregnant cow more so than the nonpregnant cow." (Chem. Abs. 51: 13101.)

796. LUICK, J. R., BODA, J. M., and KLEIBER, M. Some biokinetic aspects of calcium metabolism in dairy cows. *Amer. Jour. Physiol.* 189: 483-488. 1957.

"A study was made to det. how cows which have been prefed low-Ca:high-P diets are better able to maintain normal serum Ca levels than are cows prefed high-Ca:low-P diets. Ca^{45} was employed as a tracer. A procedure is presented by which the reservoirs of mobilizable skeletal Ca can be estd. It appears that these reservoirs of skeletal Ca are larger and are turning over more slowly in cows prefed low-Ca:high-P diets. Since it was found that these cows were in neg. Ca balance, the larger stores of mobilizable Ca must accrue at the expense of stable bone Ca. A comparison of bone Ca specific activity to serum Ca specific activity indicates that nearly all the trabecular bone Ca and from 7 to 17% of the cortical bone Ca may be included in the mobilizable Ca pool." (Chem. Abs. 51: 16770.)

797. MERCER, D. N., and others. Effect of interruption of milking on the carotene and vitamin A and proximate composition of milk and on the calcium content of blood serum. *Jour. Dairy Sci.* 32: 977-985. 1949.

H. D. Eaton, R. E. Johnson, A. A. Spielman, W. N. Plastryge, L. D. Matterson, and L. Nezvesky, joint authors.

"Data on 18 cows indicate that interruption of milking results in significant increases in the concns. of carotene and vitamin A in the milk. With the exception of lactose, the proximate constituents also increased in concn.; lactose content decreased. The total amt. of these nutrients secreted for the first 3 days after interruption was significantly lower for the proximate constituents, but no significant differences were noted for vitamin A and carotene. Interruption of milking, resulted in a significant elevation of blood serum Ca during the period of interruption." (Chem. Abs. 44: 4985.)

798. MIRANDA, C. P., and BACIGALUPO, A. The calcium, phosphorus, and magnesium balance in milk cows of high medium, and low production. *Agronomia [Lima]* 20: 8-14. 1955.

"The Ca, P, and Mg balance in cows with high and medium milk production was pos.; in cows of low production it was neg. Ca and P were excreted mostly in the feces, less in the milk, and very little in the urine. Mg was excreted mostly in the feces, less in urine, and very little in milk." (Chem. Abs. 50: 7260.)

799. PECHER, C., and PECHER, J. Radiocalcium and radiostrontium metabolism in pregnant mice. *Soc. Expt. Biol. and Med. Proc.* 46: 91-94. 1941.

"By use of radioactive salts of Ca and Sr it was shown that part of the Ca and Sr previously fixed in the skeleton of a mouse migrates to the fetus during the last days of pregnancy and to the offspring through the milk. When

radioactive Sr lactate is injected intravenously into lactating mice and cows appreciable amts. appear in the milk." (Chem. Abs. 35: 2196.)

800. PEETERS, G., and others. [Incorporation of D.L.-cystine-S³⁵ into milk proteins by the mammary gland.] Arch. Internatl. de Pharmacodyn. et de Thér. 109: 415-424. 1957.

R. Coussens, R. De Loose, and A. Van Den Hende, joint authors.

"A half of an isolated udder from a lactating cow was perfused for 90 min. with 9 litres of blood containing cystine-S³⁵. The radio-activity of the total blood at the end of perfusion, as in the experiment with methionine-S³⁵ (Coussens *et al.*, Ann. Endocrinol., Paris, 1954, 15, 1000) was much below the original level. The whey proteins contained more activity than casein and plasma proteins. With incubations *in vitro* the activity of plasma proteins was about the same, but that of milk proteins was much less. In the previous work with methionine-S³⁵ casein contained much more activity than the whey proteins and there was more activity in these and less in the plasma proteins than when cystine-S³⁵ was used. Three hours after intravenous injection of cystine-S³⁵ into a lactating sheep the activity of whey proteins reached a maximum and was 6 and 150 times as great as in casein and plasma proteins. This indicated that the mammary gland synthesised milk proteins from amino acids in plasma and that plasma proteins were less readily used." (Nutr. Abs. and Rev. 27: 5373.)

801. PEETERS, G., DEBACKERE, M., and SIERENS, R. Study of the oxidative cycle of hexosemonophosphates in mammary tissue by chromatography on paper. Arch. Internatl. de Physiol. 65: 324-336. 1957.

"Mammary tissue was obtained as soon as possible after death from lactating cows, sheep, goats, mares, dogs, cats, rabbits, rats and guinea pigs. The large animals were milked out before death to avoid milk in the tissue as much as possible, and the small animals were left with their young. Homogenates were prepared for incubation. Before incubation all the homogenates contained glucose and lactose, those from dog and rabbit contained ribose and those from cows sedoheptulose. All these sugars and fructose were recovered in the course of incubation. When homogenates from rabbit and cow were incubated with added adenosine triphosphate (ATP) the amounts of sedoheptulose were much reduced. In the absence of phosphorylated substrate not more than traces of phosphate esters could be found in homogenates, even when NaF was added. When glucose-6-phosphate was added it was possible to detect in homogenates from cow, cat, dog, rat and rabbit fructose-6-phosphate and sedoheptulose-phosphate and unidentified esters related to triose-phosphates. When ribose-5-phosphate was added the esters found were glucose-6-phosphate, fructose-6-phosphate, sedoheptulose-phosphate and triose-phosphate. In 2 experiments with homogenates from cows transient appearance of ribulose-phosphate and erythrose-phosphate was found. In incubations with milk or colostrum glucose-6-phosphate rapidly gave rise to fructose-6-phosphate. Ribose-5-phosphate was not changed in normal milk, but in colostrum it gave rise to a little sedoheptulose-phosphate. Esters of lactose or galactose were never found. When homogenates were fractionated in the ultracentrifuge the enzymes of the oxidation cycle were found to be in the supernatant fluid, so was the phosphoglucumutase. Microsomes and mitochondria never formed sedoheptulose-phosphate, and the fact that they transformed glucose-6-phosphate to fructose-6-phosphate, may have been due to adsorption of phosphohexo-isomerase.

Phosphohexo-isomerase was found in the milk of cow, dog, sheep, pig and woman and sometimes in mare's milk. In the cow it was higher in colostrum than in milk and still higher in mastitis." (Nutr. Abs. and Rev. 27: 5362.)

802. PEETERS, G., GOVAERTS, J., and SIERENS, G. Metabolism of glucose in the isolated and perfused

udder of the cow. Arch. Internatl. de Pharmacodyn. et de Thér. 110: 367-373. 1957.

"A half udder from a cow in normal lactation was perfused for 125 min. with 10 litres of blood supplemented with 20.8 mg. (0.75 mC.) of glucose uniformly labelled with C¹⁴ and a drip of 0.67 per cent unlabelled sodium acetate solution. Finally, pitocin was given, the milk was collected and the udder was ground up. Of the C¹⁴ administered 5.91 per cent was eliminated as 14CO₂; the activity of expired CO₂ increased gradually throughout the experiment. The specific activities were, in the milk, lactose 1.241, glycerol 0.039 and non-volatile fatty acids 0.005; in the udder, glycogen 0.721, glycerol 0.071, non-volatile fatty acids 0.012, water-soluble volatile fatty acids 0.046. The low activity of the fatty acids suggests that in the presence of acetate glucose passes into a direct oxidative cycle and contributes little to the formation of acetylcoenzyme." (Nutr. Abs. and Rev. 27: 5359.)

803. PLUMLEE, M. P., and others. Placental transfer and deposition of labeled calcium in the developing bovine fetus. Amer. Jour. Physiol. 171: 678-686. 1952.

S. L. Hansard, C. L. Comar, and W. M. Beeson, joint authors.

"Data are presented on the uptake and turnover of labeled Ca in the dam and 8-month fetus at 10 min., 8 hrs., 30 hrs., and 168 hrs. after intravenous injection into the pregnant bovine, and similarly in the 3½-month, 6-month, 7½-month, and 8½-month-old fetus at 7 days after oral administration to the pregnant bovine. Ca, P, and ash values are also reported. There was relatively free movement of Ca⁴⁵ across the placenta. The equil. of Ca ions between blood of fetus and dam was not observed until some time after the equil. had been attained between blood and soft tissues of the dam, suggesting the existence of some degree of barrier. Fetal bones showed a greater uptake of Ca⁴⁵ and turnover than did the maternal bones. Progression of mineralization in the fetal bones was at a max. some time between the 4th and 7th month as indicated both by the uptake of Ca⁴⁵ and the analytical values." (Chem. Abs. 47: 4462.)

804. PONOMAREV, P. P. Variations in the milk composition of cows kept indoors during the summer. Zhivotnovodstvo 6: 92-94. 1954.

"Variations in milk yield and milk compn. were studied during an April-November period at a farm on which the cows were kept indoors throughout the whole year. The butterfat and protein contents of the milk were highest in October-November, when large quantities of mangolds were fed, and lowest in April when the basic ration consisted mainly of silage with little hay and no green fodder was available. The P content was relatively const., but the Ca level fell immediately when green lucerne was included and did not recover until after the resumption of hay feeding." (Chem. Abs. 51: 7522.)

805. ROGERS, T. A., and KLEIBER, M. Milk fat synthesis from acetate in mammary gland of the cow. Soc. Expt. Biol. and Med. Proc. 94: 705-708. 1957.

"Acetate-2-C¹⁴ was injected into the milk cistern of the right front quarter of the udder of a lactating cow. Samples of respired CO₂ were taken continuously for 3 hr. and then at intervals up to 35 hr. The cow was milked 3, 10, 22 and 35 hr. after the injection; the milk from the injected quarter was collected separately. Milk fat from each sample was fractionated into glycerol, water-insoluble steam-volatile fatty acids, water-soluble steam-volatile fatty acids and non-volatile fatty acids and the radioactivity of the carbon of each fraction was estimated. Only a small amount of the labelled acetate diffused into the other quarters of the udder or into the rest of the body. There was a delay of several hours between formation and secretion of milk fat. Fatty acids of all chain lengths were formed from acetate; glycerol was formed from acetate on a smaller scale than fatty acids." (Nutr. Abs. and Rev. 27: 5437.)

806. SADCHIKOV, S., and ANDREEVA, O. Investigation of the radioactivity of cow milk. *Molochnaya Promysh.* 18: 34-35. 1957.

"The highest concn. of radioactivity (I) in milk was found in the fat. I of milk varied, however, from 1.5×10^{-8} to 2.4×10^{-8} c./l. and was from 13.8 to approx. 20.0% of that emitted by the Pyatigorsk mineral waters." (Chem. Abs. 52: 1500.)

807. SAPELKIN, P. A. The calcium and phosphorus compounds of the blood of high-milk producing cows during the lactation process. *Moskov. Vet. Akad. Trudy* 11: 62-72. 1956.

"Towards the dry periods of high producing milk cows the total Ca in the blood gradually increased. Approx. 15% of the Ca compds. of the blood were bound to the albumins and globulins in a complex formation, the quantity of the Ca globulins being practically insignificant. The high-milk producing cows accumulated the Ca-albumin blood complexes during the lactation period to 20-40% above the av. level of medium-milk-producing cows. Blood P in cows after the birth of a calf rose sharply, but gradually abated during the lactation period. During the period of dryness the reduction in content of P in the blood continued, and during the first period of lactation was as low as 65-68% of the normal. The inorg. P of the blood of high-milk-producing cows reached its max. during the first period of lactation, gradually falling during the second and again rising during the third period. The rise in the inorg. P content of the blood continued during the cow's dry period. The content of lipide P during the first period of lactation was at its min., during the second period at its max., but again fell during the third period. The greater part of the P compds. of high-milk-producing cows was in the form of albumin and globulin complexes. The content of the P-globulin complexes rose towards the end of the lactation, reaching its max. during the dry period. The P-albumin complexes of the blood of milk cows ran parallel to the milk yield." (Chem. Abs. 51: 9845.)

808. SAPELKIN, P. A. The nature of calcium compounds in the blood of high milk producing cows. *Moskov. Vet. Akad. Trudy* 15: 148-157. 1956.

"The content of the total Ca in the blood of high milk producing cows during the different periods of lactation was related to the time of the year and to the volume of milk yield only to a slight degree. The content of diffused Ca (ionized Ca, and Ca in the form of complex compounds, primarily as Ca-P compounds) in the blood of the cows rose towards the end of the lactation period, reaching the highest value during the dry period (during the period of lactation in cows of one group with a milk yield of 8000 kg., the Ca content was 7.81 mg. %, towards the end of the lactation period it was 8.90 mg. % and during the dry period 9.77 mg. %). The content of the diffusible Ca compds. rose in the blood of the cows. In the blood serum of all the cows under study the content of Ca-albumin complexes, active products of metabolism, was gradually tapered down from the first period of lactation to the last, reaching its lowest level during the dry period; in such instances the higher milk producing cows generally reached a comparatively lower level (in the cows of one group it dropped from 1.59-0.79 mg. % during the first period of lactation to 0.33 mg. % during the dry period; in another group of cows with an average milk yield of 6000 kg. the corresponding values were 1.65-0.97 mg. % and 0.67 mg. %). The content of Ca-albumin complexes in the blood serum of young cows was at a higher level than in the case of the older cows." (Chem. Abs. 51: 13133.)

809. SASAKI, R. Studies on physiology of lactation. Internat. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. 1955 (12): 298-300. 1956.

810. SASAKI, R., and KOYAMA, S. Fat-globule membrane material of cow milk. II. Adsorption of

radioactive calcium-45 caseinate and whey protein on milk-fat globules. *Agr. Chem. Soc. Japan, Jour.* 29: 831-833. 1955.

"A HCl-pptd. casein from skim milk was dissolved in 0.5 N NaOH at pH 6.6 a mixt. of $\text{Ca}^{45}\text{Cl}_2$ and CaCl_2 (1:20) was added to the casein soln. The mixt. was dild. to 2.5% casein soln. (contg. 0.313 g. CaCl_2 per g. casein). This radioactive Ca caseinate sol. was emulsified with 3.5% butterfat, 0.07% lecithin, and 0.13% $\text{Ca}_3(\text{PO}_4)_2$. Ca^{45} was not detected in the cream, obtained from this radioactive reconstituted milk, after 2 washings. On the other hand, butterfat was emulsified with whey and the cream before and after washing was examd. by paper electrophoresis: β -lactoglobulin was washed out after 2 washings, but other whey protein components were still adsorbed on the surface of fat globules after 4 washings. Conclusion: fat-globule membrane protein does not contain casein, but consists of a part of whey protein components and might contain some hitherto unknown component." (Chem. Abs. 50: 6532.)

811. SHIRLEY, R. L., and others. Placental transfer of Mo^{99} and Ca^{45} in swine. *Jour. Nutr.* 54: 59-64. 1954.

M. A. Jeter, J. P. Feaster, J. T. McCall, J. C. Outler, and G. K. Davis, joint authors.

" Mo^{99} was readily absorbed in sows after oral administration and was widely distributed in their tissues. Little or none was found in the various tissues of the fetuses. Ca^{45} was readily transferred to the developing fetus and a greater percentage of it was found in the fetal bones/unit of wt. than in the bones of sows. No significant differences were observed in the uptake and distribution of Mo^{99} and Ca^{45} between sows in the 1st and 2nd pregnancies." (Chem. Abs. 49: 3345.)

812. SOLNCEV, A. I., and FILATOV, G. V. Calcium metabolism in ruminants studied with Ca^{45} . *Zivotnovodstvo* 12: 53-55. 1956.

"A goat about 5 years old received in the first month of lactation a single intramuscular injection of 3 ml. of $\text{Ca}^{45}\text{Cl}_2$ solution containing 500 mg. Ca and 7 mC. activity. The goat was giving about 600 to 700 ml. milk daily at 2 milkings. The specific activity of the milk reached its peak at the morning milking, 26 hr. after the injection and that of faeces was highest at about the same time. After this the decline in both milk and faeces became progressively slower, and some activity was found in both after 61 days. In all, about twice as much Ca^{45} was recovered from milk as from faeces." (Nutr. Abs. and Rev. 27: 3770.)

813. SOLNTSEV, A. I., and FILATOV, G. V. The incorporation of phosphorus-32 from an inorganic source into milk casein. *Izv. Timiryazev. Sel'skokhoz. Akad.* 1: 227-228. 1956.

" P^{32} in the form of Na_2HPO_4 , 10 ml. soln. of 4.5 mc., was injected intramuscularly into a goat. Measurements made on the radioactivity of the milk, manure, and casein manufd. from the milk show that after 2 hrs. the activity in the milk was high, and attained a max. after 6 hrs. The manure also showed activity soon after injection." (Chem. Abs. 51: 2149.)

814. SUNDARARAJAN, T. A., KUMAR, K. S. V. S., and SARMA, P. S. Studies on the incorporation of phosphate into casein in the lactating mammary gland. *Biokhimiya* 22: 135-139. 1957.

"Dephosphorylated casein incorporated P when incubated with a homogenate of lactating rat mammary gland MgCl_2 , fluoride and adenosine triphosphate. The last was essential. Serine similarly incubated did not take up P. Both casein and dephosphorylated casein incorporated P^{32} when incubated with labelled phosphate and a particulate fraction, but not a homogenate, of rat mammary gland. Trace amounts of phosphopeptides similar in amino acid composition to casein phosphopeptide were found in mammary gland from lactating rats." (Nutr. Abs. and Rev. 27: 5361.)

815. SWANSON, E. W., and others. A study of variations in secretion of Ca^{45} by the mammary glands of dairy cows. *Jour. Dairy Sci.* 39: 1594-1608. 1956.

R. A. Monroe, D. B. Zilversmit, W. J. Visek, and C. L. Comar, joint authors.

"Expts. are described in which the specific activities of milk Ca and blood Ca have been compared after intravenous and oral doses of radioactive Ca administered to lactating dairy cows, along with investigations to det. the cause of the differences observed. After intravenous doses the specific activity curve of blood Ca as it declined passed through the peak of the milk Ca curve corrected to av. time of secretion. After the peak, the milk specific activity usually remained higher than the blood but continued to decline at the same rate as blood. After oral doses wide variations in response have been observed. In some animals the specific activity of milk Ca has exceeded the highest observed specific activity of blood, but in others they were nearly equal at their max. After the peak the decline curves have been very similar to those after an intravenous dose. Cows that had previously developed milk fever were found to exhibit greater differences in specific activities of blood and milk Ca in early lactation than other cows; yet these differences were observed also in cows that were not highly susceptible to milk fever. No satisfactory explanation for the excessive proportion of radioactive Ca in milk has been discovered. Paper electrophoresis, arterial-venous differences, and expts. involving the continual injection of stable Ca failed to support the hypothesis that a high specific activity fraction of blood Ca existed which might be used preferentially for milk formation. Mass spectrographic analysis of blood and milk Ca of one cow showed no differences in proportions of 6 Ca isotopes, which indicated that the udder was not concg. Ca^{45} per se. The existence in the udder of a variable Ca reservoir from which the Ca is not readily exchanged with blood Ca, and which is used for milk formation, has been postulated to explain the differences in time between equal specific activity values of blood and milk Ca." (Chem. Abs. 51: 3779.)

816. TYLER, S. A., and GURIAN, J. The excretion of Sr^{90} by goats. U.S. Atomic Energy Comm. ANL-4488, p. 11-20, 1950.

817. VISEK, W. J., BARNES, L. L., and LOOSLI, J. K. Calcium metabolism in lactating goats as studied with Ca^{45} following oral and intravenous administration. *Jour. Dairy Sci.* 35: 783-792. 1952.

"In studies involving oral administration of Ca^{45} , the amt. of radioactivity appearing in the milk was a function of the total amt. of milk Ca being secreted. It also appeared that the level of Ca^{45} excreted in the urine followed closely the level of activity in the blood. What influence the level of dietary P exerted on the results could not be detd. from the data. The amt. of Ca absorbed from the gastrointestinal tract as measured by the level of Ca^{45} appearing in the blood stream following oral administration was related closely to the Ca requirements for lactation. The higher the level of milk production, the greater was the percentage of Ca^{45} present in the plasma 24 hrs. after an oral dose. It is concluded that the rate of Ca absorption in these studies was governed by the needs of the animal." (Chem. Abs. 47: 185.)

818. VISEK, W. J., and others. Calcium metabolism in dairy cows as studied with Ca^{45} . *Jour. Dairy Sci.* 36: 373-384. 1953.

R. A. Monroe, E. W. Swanson, and C. L. Comar, joint authors.

"Ca metabolism in dairy cows was studied at parturition and at various stages of lactation. Data are presented on the appearance of Ca^{45} in the blood, milk, feces, and urine at various times following single oral and intravenous doses. The blood-milk pattern also is given for a cow fed Ca^{45} daily over several months of a lactation period. When Ca^{45} was injected into 2 dairy cows in single doses at about 20 days prepartum, much of it was deposited in the mammary glands, and remained until the animals were

milked. Ca^{45} intravenously administered during lactation was deposited in the milk in amts. directly correlated with the total amt. of milk Ca secreted. During 4 days after injection a cow producing 4 kg. milk/day secreted 19% of the Ca^{45} dose, whereas the same cow and another one producing about 7 kg./day secreted 34%. After oral administration these cows secreted 4-6% of the Ca^{45} in their milk in 4 days at daily levels of milk production which were about the same as those after intravenous injection. Evidence is presented that Ca ions are readily interchangeable between the various Ca fractions of blood, and on this basis a simple method for quant. estn. of these fractions is suggested. These data on Ca fractions, as well as the blood and milk specific-activity relation after oral and intravenous administration, are presented and discussed in terms of precursor-product relations." (Chem. Abs. 47: S207.)

819. VOLKOV, D. T., and LIPATOVA, N. A. Calcium and phosphorus metabolism in rabbits during gestation and lactation. *Moskov. Vet. Akad. Trudy* 15: 111-119. 1956.

"Observations were made over the metabolism of Ca and P during the periods of rest, pregnancy, and pregnancy coinciding with lactation in chinchilla rabbits. The rations of the animals during the different periods varied in their Ca and P content, being particularly rich in P. Results indicated that during the rest period a balance equilibrium existed between Ca and P which was pos. During the period of pregnancy and pregnancy coinciding with lactation the Ca balance was neg. and P balance pos. The results also indicated that the content of Ca in the blood and in the urine was highest during the period of rest; it was reduced during the period of pregnancy and reached its lowest level during the period of pregnancy coinciding with lactation. The changes in the content of P were only slight at all periods studied." (Chem. Abs. 51: 14066.)

820. WARD, G. M. Calcium balances and changes of some blood and urinary constituents as related to parturient paresis in dairy cows. *N.Y. Acad. Sci. Ann.* 64: 361-369. 1956.

"Blood and urinary concns. of Na, K, and Cl were detd. from 30 days prepartal to 30 days postpartum in 16 dairy cattle giving birth to young; 3 of the parturitions were followed by attacks of parturient paresis. Ca, Na, and K balances were also detd. Blood concns. of Ca, Na, K, Cl, and pyruvic lactic, and citric acids and hematocrit values were measured in 8 cows which had milk fever, and in 3 which calved normally; samples were taken prior to and following treatment of the ill cows with Ca borogluconate. Near parturition concns. of blood Cl and K increased while Na decreased; normal cows and those with milk fever were similar in this respect. Urinary excretion of Na, K, and Cl decreased at parturition, with K and Cl excretions decreasing more sharply in the cows with milk fever; the chief cation excreted was K. Serum Ca in the cows with milk fever before treatment was 5.0 mg. % and in the 32 days after treatment was 9.7-10.4 mg. %. In the cows which calved normally serum Ca averaged 7.7 mg. % on the day of calving and was 9.0-10.6 mg. % in the 30 days thereafter. Pyruvic and lactic acid concns. were higher, citric acid lower, and hematocrits higher in the cows with milk fever prior to than after treatment. In the normal cows wholeblood pyruvic acid concns. decreased slightly postpartum, lactic and citric acid concns. increased, and hematocrit reading was essentially unaltered. Cows which developed milk fever showed severe neg. Ca and K balances for about 15 days prior to parturition, while cows calving normally maintained Ca reserves. Primiparous cows apparently increased their Ca stores. In the prepartal period K balances closely followed those of Ca; in the postpartum period K balances closely followed those of Ca; in the postpartum period K balances were pos. in normally calving mature and primiparous cows, and neg. in mature cows which developed milk fever and in some mature cows which did not. The only obvious differences in

Na balances were in the postpartum period when mature cows which developed milk fever and mature Guernseys and Holsteins which did not were in neg. balance, while Na intake and excretion were approx. equal in mature and primiparous cows calving normally. It is suggested that the prepartal neg. Ca balance in cows which developed milk fever is due to mobilization of skeletal Ca which is then lost through the intestines." (Chem. Abs. 51: 9897.)

821. WILLIAMS, W. F., and TURNER, C. W., Guanine and guanosine deaminase activity of rat mammary gland homogenates during pregnancy and lactation. Soc. Expt. Biol. and Med. Proc. 95: 51-53. 1957.

"Rat mammary gland homogenates were found to deaminate both guanine and guanosine in all the physiological states studied. Rate of guanine deamination was consistently about 3 times that for guanosine. There was a marked drop from the level found during pregnancy, to a lower level during lactation." (Internatl. Abs. Biol. Sci. 8: 2055.)

822. WRIGHT, N. C. Inorganic constituents of milk. Science 69: 78. 1929.

Spectograms were obtained from milk samples taken from various sources in the United States and Britain in order to determine the elements normally occurring in milk. Strontium was present in trace amounts.

823. ZHIVKOV, V. Calcium and phosphorus content of blood serum of lactating and nonlactating ewes. Izv. Inst. Eksper. Vet. Med. 3: 149-153. 1954.

"The av. Ca and P contents of the blood serum were 108 and 171 p.p.m., resp., for nonlactating and 99 and 148 p.p.m. for lactating ewes." (Chem. Abs. 51: 7527.)

AGE

824. BONNER, J. F., JR. The influence of age on the uptake of radioactive phosphorus by the skeleton. U.S. Atomic Energy Comm. AEC-1967, 19 p. 1948.

825. COPP, D. H., and others. The effect of age and low-phosphorus rickets on calcification and the deposition of certain radioactive metals in bone. Conf. on Metabolic Interrelat. Trans. 3: 226-252. 1951.

J. G. Hamilton, D. C. Jones, D. M. Thomson, and C. Cramer, joint authors.

"The retention of radioactive Ca^{45} (I), $\text{Sr}^{89,90}$ (II), Ba^{140} (III), Y^{88} (IV), and Ce^{144} (V), was studied, following intravenous injection, in young normally growing rats, in adult rats, and in young rats with low-P rickets in which new osteoid matrix was forming but deposition of bone salts did not take place. I and II were removed from the plasma much more slowly in adult rats than in the other 2 groups. The uptake by adult bone was continuous during the 1st 2 hrs. and reached a max. within 4 hrs. In young rats, the skeletal uptake was more rapid, reaching a max. within 30-60 min., and the deposited isotope appeared to remain fixed in the bone. In rachitic rats, (a) the rapid uptake was followed by active loss from the skeleton so that only $\frac{1}{2}$ was left at 24 hrs., suggesting a labile combination with bone possibly as a result of exchange with labile Ca on the surface of the crystals of bone salt; and (b) the plasma clearance of I and II during the first 24 hrs. was 10-15 times as great as in normal animals and approached the glomerular filtration rate, thus appearing to be the result of a low-P rickets on excretion by the kidney. In normal rats injected with I or II and then transferred to a low-P diet, excretion of I and II was 5-6 times greater in the young rats than in the controls on a normal-P intake and much greater in the adults on a low-P intake than in the young with low-P intake. The 1st effect of a low-P diet was a fall in the serum P level and its disappearance from the urine. In normal rats injected with I and then changed to a diet adequate in P but low in Ca, the I excretion was reduced as compared with controls; this suggests that a

low-Ca diet would be of little value in increasing removal of radioactive alk. earth metals such as I and II or radium. Radioautographs of the rachitic femur showed that I and II were deposited only in the presence of bone salt, whereas IV, V, and other heavy metals are laid down in the uncalcified osteoid matrix. In normal adults given V or Am^{241} , the radioactive material was distributed in the neighborhood of the small blood vessels in the cortex. Although qualitatively similar to I and II, a relatively greater retention of III in adult and rachitic animals was observed." (Chem. Abs. 46: 11398.)

826. FORBES, G. B., MINZER, G. L., and LEWIS, A. Effect of age on radiosodium exchange in bone (rat). Amer. Jour. Physiol. 190: 152-156. 1957.

"On a wet wt. basis, bone from young animals contains more water and Cl, and less Na and Ca than that of the adult. In the young animal, a much larger fraction of the skeletal Na exchanges readily with Na^{22} . However, since the skeleton of the older animal has a much higher Na concn., the total amt. of Na per unit skeletal wt. which is available for exchange does not vary appreciably with age. Na in bone is considered metabolically to consist of 3 phases: fluid phase Na, represented by that contained in the Cl space; the exchangeable portion of the crystal phase Na; and the nonexchangeable Na of the crystal phase. Changes in the magnitude of each of these phases occurs during growth in the rat." (Chem. Abs. 51: 18232.)

827. FREYDBERG-LUCAS, V., and VERZÁR, F. Turnover of calcium-45 in young and old animals. Experimentia, sup. 4, p. 88-95. 1956.

"Rats varying in age from 3 to 33 months were given single injections of 0.02 mc. of Ca^{45} . The animals were killed 48 hrs. thereafter. In the skeleton, exchange is very rapid at 3 months; it declines rapidly until puberty and remains relatively const. thereafter. In the aorta Ca exchange is lowest at 3 months; it reaches a max. at 30 months. Also in tendon, skin, brain, kidney, small intestine, and adrenals there is an increased exchange in mature animals. Exchange in the lung is extensive with an increase from 10 to 30 months. Exchange in large intestine was max. at 10 months and declined thereafter." (Chem. Abs. 51: 13195.)

828. FREYDBERG-LUCAS, V., and VERZÁR, F. Calcium metabolism of various organs in young and old animals. Gerontologia 1: 195-213. 1957.

"Male albino rats, 35 animals from 3 to 31 months, were given intramuscularly 20 microcuries Ca^{45} in 1 ml. Ringer's soln. After 48 hrs. they were killed by bleeding under ether narcosis. Usually 100 mg. tissue, including femur epiphysis, femur diaphysis, rib, aorta, tendon, muscle, skin, lung, brain, kidney, large and small intestines, and liver, were put on planchets, dried, ashed, and assayed for Ca^{45} by Geiger tube with scaler. On 12 animals the above tissues were assayed for Ca content by KMnO_4 or Complexion III titration methods after oxalate pptn. of the Ca. The radioactivity is given as per cent of initial dose times 10^4 (bone) or 10^5 (tissues soft). For the bones studied av. activity dropped sharply up to 10 months of age: rib activity fell from 90 (in 3-month old animals) to 16 (in 10-month old animals), epiphysis from 45 to 12, and diaphysis from 22 to 7. Thereafter the activity remained relatively stable. The Ca content of bone increased moderately up to the 10th month, then stabilized. For aorta the av. radioactivity increased steadily with age: 12 at 3 months, 55 at 31 months. The Ca exchange is thus quite high here even though the actual Ca content is much lower than in bone. The remaining tissues behaved similarly, but in no case was the increase of Ca^{45} uptake with age so large as for the aorta. The large intestine showed an increase in Ca^{45} uptake up to 10 months, then a fall, presumably because of its excretory activities. The relation of the Ca^{45} to elastin aging is discussed; it is concluded that except in aorta and lung such elastin aging cannot account for increases of Ca^{45} uptake." (Chem. Abs. 52: 4765.)

829. HANSARD, S. L., COMAR, C. L., and DAVIS, G. K. Effects of age upon the physiological behavior of calcium in cattle. *Amer. Jour. Physiol.* 177: 383-389. 1954.

"The absorption and movement in the body of labeled Ca was studied as a function of age in 36 cattle. Consideration is given to the use of Ca^{45} data for the interpretation of the behavior of the stable Ca normally present. The typical excretion rate of unabsorbed Ca showed a 3-fold increase for the aged animals. Equations are presented for the disappearance of Ca^{45} from blood function of age, indicating that the rate of exchange of Ca ions between blood and other compartments decreased significantly with increasing age. From the comparative specific activities of soft tissue and bone it was possible to est. the relative percent of exchangeable Ca in the skeleton; this value tended to decrease with age." (*Chem. Abs.* 48: 1089.)

830. HANSARD, S. L., COMAR, C. L., and PLUM-LEE, M. P. The effects of age upon calcium utilization and maintenance requirements in the bovine. *Jour. Anim. Sci.* 13: 25-36. 1954.

"Concurrent chem. and radio-Ca balance studies showed that absorption or true digestibility or both were greatest in young animals, decreased rapidly to sexual maturity, more slowly to maturity, and again decreased in aged animals. Daily endogenous fecal Ca increased with age and wt. from 0.42 g. at 10 days to 3.3 g. at 6 months to 8.0 g. at maturity. Maintenance requirements per 100 lb. body wt. calcd. from the endogenous and true digestibility values ranged from 0.5 g. at 10 days to 2.0 g. at 6 months and then remained relatively const. to maturity." (*Chem. Abs.* 48: 7130.)

831. HANSARD, S. L., and CROWDER, H. M. The physiological behavior of calcium in the rat. *Jour. Nutr.* 62: 325-339. 1957.

"The 141 rats from a highly inbred Wistar strain were maintained on a ration Ca-3 containing 0.4 per cent P and 0.5 per cent Ca. After definite periods on the ration selected animals from each group were given a single oral or intraperitoneal tracer dose of $\text{Ca}^{45}\text{Cl}_2$ at 1.5, 4, 12, 24, 48 to 72 and 106 weeks of age. Each rat then underwent a 96-hr. balance study (Hansard and Comar, *Nucleonics*, 1953, 11: 44) before being killed for estimation of Ca^{45} in tissues. Ca, P, ash and Ca^{45} were estimated in feces and urine. Absorption, retention and excretion of Ca were greatest in young rats, decreased rapidly to the age of sexual maturity and fell more slowly to full growth and old age. Daily endogenous faecal Ca losses and requirement for maintenance increased slightly to maturity and much more in the aged animal. Tissue Ca^{45} data, corrected for difference due to age, showed that deposition in tissues reflected the physiological status of the animal." (*Nutr. Abs. and Rev.* 28: 848.)

832. LANSING, A. I., ROSENTHAL, T. B., and KAMEN, M. D. The effect of age on calcium binding in mouse liver. *Arch. Biochem.* 20: 125-130. 1949.

"The activity of Ca^{45} in livers of young and old rats subsequent to the intraperitoneal administration of Ca^{45} indicated that with young liver Ca uptake is low and turnover rapid whereas with old liver Ca uptake is high and turnover low. Intracellular Ca may be largely assocd. with a lipide and ribonucleoprotein." (*Chem. Abs.* 49: 6715.)

833. PICKERING, D. E., and others. Chemical growth dynamics of the skeleton in the immature rat. I. Normal chemical composition and growth. *Amer. Jour. Dis. Children* 92: 276-283. 1956.

R. F. Foran, K. G. Scott, and J. T. Crane, joint authors. "The dynamics of chem. growth of the skeleton was studied in 95 normal immature male rats (1-75 days of age) by serial analyses of the total skeleton and long-bone aliquots, Ca^{45} recoveries, and balance techniques. Chem. growth of the rat skeleton, as represented by increment in total skeletal ash, Ca, and Mg from birth to 75 days, is

disproportionately rapid when compared with other major systems combined. The Ca present at birth (12 mg.) is dild. by an addnl. 1700 mg. by 75 days of age. Approx. 65% of the ingested Ca enters the skeletal pool during this period of growth. Ca^{45} incorporated into the skeleton is retained nearly 95% by the growing animal, despite a high rate of skeletal turnover. This period of life is characterized by continuous changes in the chem. compn. of bone. There is an increase in the mineral elements of the skeleton and a relative decrease in the org. matrix. In addn., a progressive change occurs in the chem. compn. of the ash, represented by an increasing Ca content. Rates of change in chem. growth and turnover are not equal in long bones and the entire skeleton. Until chem. growth activity has reached uniformity throughout the skeleton, it is fallacious to est. magnitude of change in the former from analyses of select parts." (*Chem. Abs.* 50: 17079.)

834. SILBERBERG, M., and SILBERBERG, R. Studies concerning the specificity of the skeletal effects of enriched diets in aging mice. *Lab. Invest.* 6: 372-382. 1957.

"In male mice of strain C57BL, epiphyseal ageing was accelerated by lifelong feeding of a diet containing 24% animal fat. This was due partly to the high calorie intake of the animals consuming the high fat ration, and partly to the fat specifically. The evolution of osteoarthritis was likewise promoted by both the increased calorie intake and the presence of fat as such. Single housing decreased food consumption and produced a state of relative undernourishment in mice thus kept, as compared to animals kept in groups. Underfeeding manifested itself in retarded development and ageing of the bones and in a lowered incidence and attenuation of the osteoarthritic lesions occurring spontaneously in ageing mice." (*Biol. Abs.* 31: 38400.)

835. TARJAN, R., and SZOKE, K. Changes with increasing age in the organic and the inorganic bone substance and in the firmness of bone in rats. *Ztschr. f. Physiol. Chem.* 308: 1-4. 1957.

"Weanling Wistar rats received a normal diet contg. 15% protein. The changes in the ash, Ca, P, and N contents of the long hollow bones were detd., and the firmness of the bones was tested up to 42 weeks of age. It was found that the ash content increased with age, while the N content decreased. There was no measurable change in the Ca:P ratio of the ash, but the Ca:N ratio increased. Collagen and compds. similar to it showed the smallest decrease with age among the N-contg. substances. The firmness of the bones/unit wt. in 20-week-old rats was 20-25% higher than in 3-week-old ones. No relation was found between the citric acid content and the age of bones." (*Chem. Abs.* 51: 14951.)

836. THOMSON, D. M. Effect of age and low phosphorus rickets on metabolism of Ca^{45} in rats. *U.S. Atomic Energy Comm. UCRL-2302*, 130 p. 1953.

"Tracer techniques, employing Ca^{45} , were applied to a comparison of Ca metabolism in adult, young and rachitic rats. Particularly with respect to the skeletal uptake and urinary and fecal excretion of Ca and the effects of increased or decreased Ca or P supply of Ca metabolism. Data are presented in tabular form." (*Nuclear Sci. Abs.* 8: 997.)

FLUORIDES

837. BELANGER, L. F., and others. The effects of fluoride feeding on the organic matrix of bones and teeth of pigs as observed by autoradiography after in vitro uptake of calcium-45 and sulfur-35. *Jour. Biophys. and Biochem. Cytol.* 3: 559-566. 1957.

W. J. Visek, W. E. Lotz, and C. L. Comar, joint authors. "Demineralized sections of fluorinated bones and teeth were soaked in $\text{Ca}^{45}\text{Cl}_2$ or $\text{H}_2\text{S}^{35}\text{O}_4$ and studied by autoradiography. The portions of tissue which do not become mineralized (cartilage, prebone, predentine, and pre-

cementum) showed an increased Ca uptake in treated sections. This uptake might be the result of a nonspecific absorptive property of the tissue exmd. This hypothesis was tested by treating comparable tissue sections with S^{35} . This isotope was concd. to a greater extent in bone, dentine, and cementum of fluoride-treated pigs than in controls. It was suggested that the increased Ca uptake in fluoride-treated pigs was related to an increase in chondroitin SO_4 in these tissues." (Chem. Abs. 52: 517.)

838. BELANGER, L. F., and others. The effects of fluoride ingestion on the organic matrix of the teeth of growing pigs. Jour. Dent. Res. 37: 264-274. 1958.

W. J. Vissek, W. E. Lotz, and C. L. Comar, joint authors. "Progressive changes were recognized in the dentin and cementum of the teeth of pigs fed a diet containing a large dose of fluoride (1,000 p.p.m.) for periods of 30 and 60 days. The changes were more extensive in the incisors than in the molars. Dentin and cementum showed a graded decrease of staining by the periodic acid-Schiff technique and toluidine blue metachromasia. Predentin and precementum were hyperplastic, occasionally tumoral. The number of odontoblasts and cementoblasts was increased at 30 and decreased at 60 days. The pulp cavity showed hypervascularization and decrease in stainable ground substance. Round, clear masses, probably containing CaF_2 , appeared in newly formed dentin and cementum of fluoridized animals. Homogeneous, compact, blue-white ash of unknown identity was detected in spodograms of demineralized sections of dentin and cementum from fluoridized animals. The significance of these findings in relation to normal mineralization is discussed." (Author's summary.)

839. BELANGER, L. F., and others. Rachitomorphic effects of fluoride feeding on the skeletal tissues of growing pigs. Amer. Jour. Path. 34: 25-35. 1958.

W. J. Vissek, W. E. Lotz, and C. L. Comar, joint authors. "Young pigs fed for 30, 60, and 90 days on a diet containing 1,000 parts per million of sodium fluoride showed defective growth and mineralization of bones, costochondral beading, softened and deformed epiphyseal plates, and enlarged and malformed bone trabeculae. Histochemical studies of demineralized sections revealed a decrease in the stainable polysaccharides and an accumulation of salt, the solubility of which resembled that of calcium fluoride. The larger portion of the deposit observed in spodograms seemed related to an organic calcium combination, the significance of which is discussed in relation to the mechanism of mineralization and is compared with vitamin D deficiency and strontium rickets." (Author's summary.)

840. CICARDO, V. H., MURACCIOLE, J. C., and DE LERNER, S. J. Fixation of calcium-45 by the bones and teeth of rats in experimentally induced fluorosis. Rev. de la Soc. Argentina de Biol. 31: 71-74. 1955.

"The uptake of Ca^{45} in rats injected 3 months i.p. with Na-fluoride showed that calcification of the bones was more evident than in the controls but that one single injection was unable to induce this increase. The teeth, whose metabolic activity is much inferior to that of the bones, were not affected during the short time of observation; it is assumed, however, that prolonged intoxication would be capable of affecting the teeth. This would explain the phenomenon of greater resistance to dental caries in subjects whose teeth are treated with fluoride." (Internatl. Abs. Biol. Sci. 4:1608.)

841. CICARDO, V. H., MURACCIOLE, J. C., and DE LERNER, S. J. Radiocalcium fixation in bones and teeth of rats in experimental fluorine poisoning. Rev. de la Soc. Argentina de Biol. 31: 63-70. 1955.

842. COMAR, C. L., and others. Effects of fluorine on calcium metabolism and bone growth in pigs. Amer. Jour. Anat. 92: 361-389. 1953.

W. J. Vissek, W. E. Lotz, and J. H. Rust, joint authors. "The interrelated effects of dietary fluoride and feed

intake on bone growth, body growth, Ca^{45} behavior, bone pathology, and feed utilization were demonstrated in young pigs. A fluorine level of 1,000 p.p.m. in the ration reduced the appetite and caused a decrease in bone growth, body growth, and feed required per unit of skeletal growth. There was an increase in feed required per unit weight gain. When animals were restricted to the same dietary intake, levels of 200 and 1,000 p.p.m. fluorine caused a reduction in bone growth. Limiting the dietary intake caused a decrease in bone growth, body growth, and feed required per unit of bone growth; however, it caused an increase in feed required per unit of weight gain. Autoradiograms showed that in the fluorine-treated animals there was a process occurring that tended to remove the Ca^{45} originally deposited in or directly below the epiphyseal regions. It is suggested that the fluorine intake caused an increased rate of bone resorption in the primary and secondary spongiosa. The proportion of the epiphysis occupied by hypertrophied cartilage cells was found to be a reliable measure of the rate of bone growth under the conditions of this experiment." (Author's summary.)

843. GOLDENBERG, H., and SOBEL, A. E. Calcification. XII. Cation-linked inhibition by fluoride and cyanide ions in β -glycerophosphate medium. Soc. Expt. Biol. and Med. Proc. 85: 275-280. 1954.

"The influence of several ions on *in vitro* calcification of bone cartilage from rachitic rats in β -glycerophosphate (I) medium was compared with their effects in inorg. phosphate soln. at 2 phosphate levels which gave comparable degrees of calcification. Cyanide did not interfere in the absence of Mg, but partially blocked calcification in the presence of Mg at some but not all phosphate levels. Calcification in dil. I soln. was blocked by NaF in presence of Mg. In the absence of Mg, inhibition by $10^{-4}M$ fluoride was noted during the first few hrs. but was not evident on prolonged incubation. Mineral deposition with $10^{-3}M$ fluoride in absence of Mg exceeded that in fluoride-free controls. At high inorg. and org. phosphate levels the fluoride block in the presence of Mg was partially overcome. There is definite similarity in the response of the calcifying mechanism in both inorg. phosphate and I media to the action of F^- or CN^- in the presence and absence of Mg^{++} . Sr^{++} , Ba^{++} , and Mn^{++} share with Mg^{++} the property of mediating the cyanide inhibition of calcification." (Chem. Abs. 48: 7774.)

844. IRVING, J. T. Action of fluorine upon the calcification of the dentine in rats with low calcium rickets. Jour. Dent. Res. 28: 16-25. 1949.

"Albino rats on a rachitogenic ration (Ca:P ratio 0.29) received subcutaneously a single dose of 2% NaF soln., using 8 mg. F per kg. body wt. A fine calcified line formed in the predentine. In these animals, and in those treated in the same manner but also given a single dose of 27 I.U. vitamin D by mouth, calcification of the predentine occurred on the enamel side of this fine line up to and blending with the line; on the pulpal side of this line a fine irregular zone of matrix did not calcify. Subsequently formed matrix calcified as usual." (Chem. Abs. 43: 6295.)

845. LIKINS, R. C., and others. The effect of fluorine on the metabolism of calcium and phosphorus in the rachitic rat. Jour. Dent. Res. 32: 664. 1953.

I. Zipkin, F. J. McClure, and A. C. Steere, joint authors. "Severe rickets was induced in female Sprague-Dawley rats by feeding the phosphorus-deficient diet of Coleman, Becks, et al. During an induction period of 21 days one-half of 24 litter pairs received a total of 7.5 mg. of fluorine (NaF) administered by mouth in 15 equally divided doses; corresponding pair mates served as controls. On the 21st day and each of 4 successive days all animals were administered radioactive calcium and phosphorus intraperitoneally. Twenty-four hours after the final injection, the animals were sacrificed and the femurs and mandibles dissected free. The tissues were dried to constant weight, ashed, and subjected to radiochemical analysis according to standard procedures. Per milli-

gram of ash the mean percentages of administered dose retained by control and fluorosed femurs, respectively, were for Ca^{45} , 0.090 and 0.092 and for P^{32} , 0.106 and 0.108. Similarly, the mean percentages retained by the mandibles were for Ca^{45} , 0.069 and 0.074 and for P^{32} , 0.073 and 0.074. The data indicate that the ingestion of approximately 17.2 mg. of F per kilogram of body weight did not appreciably alter the net uptake of Ca^{45} and P^{32} in the femurs and mandibles of these rats." (Author's abstract.)

846. LIKINS, R. C., and others. Effect of fluorine on the deposition of radiocalcium in the rat. *Jour. Dent. Res.* 33: 670-671. 1954.

I. Zipkin, A. C. Steere, and F. J. McClure, joint authors. Four littermates from each of eight litters of weanling female rats were distributed equally among four experimental groups. The animals of two groups received 10.0 mg. of fluorine (NaF) by stomach tube in 20 equally divided portions administered 5 days a week for 4 weeks. Those of the remaining groups served as controls and were intubated with distilled water. All animals received 1 μc . of carrier-free Ca^{45} CP by intraperitoneal injection 30 minutes after each intubation. On the 30th day the members of one fluoride and one control group were sacrificed; the remaining groups were continued without further treatment and sacrificed on the 60th day. The rats were then autoclaved and the femurs, mandibles, and teeth removed for analysis. At the end of the first 30 days the bone ash of the test animals contained approximately 30 times more fluorine (percent) than the controls, whereas the fluorine content of the incisor and molar dentine was approximately 15 times that of the controls. During the next 30 days there was a significant ($p < 0.05$) loss of total fluorine from the test femurs, mandibles, and incisor dentine, but not from the molar dentine. At 30 days the specific activity of Ca^{45} was in the following order: Femur, incisor enamel, and dentine $>$ mandible molar dentine $>$ molar enamel. The data further indicate that the rate of loss of radiocalcium from the tissues of the test animals is somewhat greater than from those of the controls, with the exception of the molar enamel.

847. McCLENDON, J. F. Similar effects of lathyrisms and fluorosis on bones of rats. *Fed. Proc.* 14: 443. 1955.

"Plants may be divided into fluoriferous and non-fluoriferous according to their ability to absorb fluoride. Fluoriferous plants fertilized with rock phosphate and fed to rats produced fluorosis of the tooth enamel. Since the African plant *Dichapetalum* can form fluoroacetate from fluoride, it seems possible that the enamel organ could form one molecule of fluoroacetate from a million molecules of fluoride and that the fluoroacetate jams the citric acid cycle (Sir Rudolph Peters). The accumulated citrate might disturb the regular secretion of tooth enamel (and bone). The bones are not as sensitive indicators as the enamel, because a large change in the mineral content of the bones is necessary in order that it be detected by X-ray or gross pathology. But by X-ray and autopsy similar effects were seen in some experiments on lathyrisms and fluorosis. Both agents were partially inhibited by calcium. Microdissection, serial sections, and serum-Ca suggested that parathyroids were involved. It seems possible that *Lathyrus* toxin jams the citric acid cycle and the accumulated citric acid lowers the ionization of calcium. These studies are being continued." (Author's summary.)

COMPLEXING AGENTS (AS PHYTATES AND CITRATES)

848. ANONYMOUS. Phytates and radioactive calcium uptake in children. *Nutr. Rev.* 13: 163-164. 1955.

849. BHARUCHA, R. P., and McCAY, C. M. The retention of calcium from gypsum and phytin by the albino rat in relation to life span. I. *Jour. Gerontol.* 9: 439-445. 1954.

"One hundred and sixty weanling albino rats received one of 4 diets: (1) 0.3% Ca phytate (I) + white flour; (2) 0.3% CaSO_4 (II) + whole-wheat flour (III); (3) 0.6% II + III; (4) 0.3% II + potato flour. The relative availability of Ca in the diets was found to be: $4 > 3 > 2 > 1$. Females showed no differences in weight due to diet, but males reached an av. maximum wt. 75 g. greater on 3 than on the others. Mortality rates were the same on all diets. Ca of II was more available than Ca of I. The rats, especially the males, tended to go into neg. balance earlier on higher than lower amts. of Ca . Bone growth continued after 280 days." (Chem. Abs. 49: 8415.)

850. BRONNER, F., and others. Studies in calcium metabolism. Effect of food phytates on calcium uptake in children on low-calcium breakfasts. *Jour. Nutr.* 54: 523-542. 1954.

R. S. Harris, C. J. Maletskos, and C. E. Benda, joint authors.

"The uptake of Ca^{45} by boys on an oatmeal breakfast was 74% as great as that of boys on a farina breakfast. The uptake of Ca^{45} by boys on a farina plus phytate meal was 45% that of farina meal. Less Ca^{45} was taken up in the presence of Na phytate than in the presence of an equiv. quantity of phytic P supplied by oats." (Chem. Abs. 49: 3336.)

851. BRONNER, F., and others. Studies in calcium metabolism. Effect of food phytates on Ca^{45} uptake in boys on a moderate calcium breakfast. *Jour. Nutr.* 59: 393-406. 1956.

R. S. Harris, C. J. Maletskos, and C. E. Benda, joint authors.

"Phytates do not exert a significant effect on Ca^{45} absorption when the meal provides 239 mg. of Ca and when the phytic P intake is 80 mg. Because this ratio of Ca to phytic P is typical of diets in the United States, it can be concluded that food phytates are no nutritional concern in this country." (Chem. Abs. 50: 17025.)

852. BRULL, L., and BERNIMOLIN, J. Physico-chemical condition of calcium and magnesium in plasma and their renal excretion. *Arch. Internat. de Pharmacodyn. et de Thé.* 108: 330-340. 1956.

"Neutral solns. of pyruvic, lactic, and tartaric acids, given intravenously to dogs, increase the Ca output in the urine. They also increase the amt. of ultrafiltrable Ca in plasma. It is suggested that urinary Ca is largely that which is chelated with compds. which are normally present in urine." (Chem. Abs. 51: 10729.)

853. CATSCH, A. Influence of condensed phosphate and citrate on the radiostrontium content in organs of the rat. *Naturwissenschaften* 44: 94. 1957.

"Four groups of σ white rats were injected with approx. 1 μc Sr^{90} - Y^{90} . One group served as control, others were injected with either citrate, Graham's salt, or Graham's salt + citrate. Rats killed after 48 hr. and Sr^{90} in both kidneys and one femur ($=\frac{1}{20}$ skeleton) was estimated. Both citrate and Graham's salt raised Sr^{90} content in kidneys and lowered it in skeleton, Graham's salt being more effective in both cases." [German.] (Internat. Abs. Biol. Sci. 7: 3446.)

854. CRAMER, J. W., PORRATA-DORIA, E. I., and STEENBOCK, H. A rachitogenic and growth-promoting effect of citrate. *Arch. Biochem. and Biophys.* 60: 58-63. 1956.

"In rats the absorption of Ca from a vitamin D-free diet contg. adequate amts. of Ca (0.5%) and a low amt. of P (0.015%) was greatly reduced by the incorporation of Na citrate and citric acid. When vitamin D was added, in addn. to the citrate, the absorption of Ca increased but the level attained was still lower than when citrate was omitted. Neg. Ca and P balances, decreases in bone ash, and increases in metaphyseal widths indicate that citrate had a rachitogenic effect." (Chem. Abs. 50: 6612.)

855. GOWDA, H. S. L., KEHAR, N. D., and AYYAR, N. K. Studies on phytic acid phosphorus metabolism in ruminants. II. Influence of high, low and medium levels

of ingestion of phytic acid phosphorus on calcium, phosphorus and magnesium metabolism. *Indian Jour. Med. Res.* 43: 609-616. 1955.

"Buffalo bulls were fed diets high, intermediate, or low in phytate P. The amt. of phytic acid hydrolyzed and the P, Ca, and Mg balances were detd. Phytic acid in the more tender feeds was utilized to a greater extent. Ca and Mg were retained best when the diet was high in Ca and low in phytate P. It is suggested that hydrolysis of phytates occurs largely in the lower intestine and not in the rumen." (*Chem. Abs.* 50: 6607.)

856. HARRISON, H. E. Interrelation of citrate and calcium metabolism. *Amer. Jour. Med.* 20: 1-3. 1956.

"Review of the influence of Ca levels on the accumulation of citrate in tissues." (*Chem. Abs.* 51: 1404.)

857. HENNEMAN, P. H., CARROLL, E. L., and ALBRIGHT, F. The suppression of urinary calcium and magnesium by oral sodium phytate: A preliminary report. *N.Y. Acad. Sci. Ann.* 64: 343-350. 1956.

"Na phytate was given orally (8.8 g. daily) to a patient with sarcoid and hypercalcemia, and to a 2nd patient with idiopathic hypercalcemia. In the 1st instance the compd. was given for 18 of 72 days, in the latter for 12 of 48 days. Urinary excretion of Ca and Mg was decreased, and was greatest in the 1st patient in whom Ca absorption was abnormally high; however, fecal excretion of Ca and Mg increased, and there was little effect on overall balance of either ion. In the 2nd patient, whose Ca absorption was only slightly greater than normal, urinary Ca decreased to normal, and fecal Ca increased to normal; urinary Mg likewise decreased and fecal Mg increased. There appeared to be no waning of the effect of Na phytate when fed for periods of 9-13 months. No toxic effects were noted in 41 subjects receiving phytate for a few days to 18 months other than diarrhea which tended to ameliorate after 3-6 weeks of phytate administration. Because phytate does not materially alter Ca balance, it is suggested that absorption of dietary Ca is blocked, but that there is no interference with reabsorption of Ca secreted into the intestine. One-half to two-thirds of the phytate P is hydrolyzed and absorbed. Na phytate is a safe therapeutic agent in adults and of value in the treatment of vitamin D poisoning, sarcoid with hypercalcemia, and certain renal stone syndromes." (*Chem. Abs.* 51: 9002.)

858. LIBBY, D. A., SCHAIBLE, P. J., and WOLTERINK, L. F. The effect of complexing agents on the uptake of Ca^{45} in chicks and embryos *in vivo*. *Poultry Sci.* 33: 1066. 1954.

Ca^{45} and complexing agents were injected into 4-, 7-, 15-, and 17-day incubated eggs and 4-week-old chicks. Tissues were taken from 19-day embryos and 1-, 3-, and 28-day-old chicks. The effects of boric acid, Na citrate, and EDTA (ethylene diamine tetra-acetic acid) on Ca^{45} uptake and distribution in femurs, blood, muscle, and yolk sac were studied. Age at injection had less bearing on final Ca^{45} uptake than did age at autopsy. In 19-day embryos and 1-day-old chicks Ca^{45} in the femur and blood was boubled by all treatments and yolk Ca^{45} was decreased. In 3-day-old chicks Ca^{45} was reduced in all tissues, apparently as a result of excretion of the tracer after hatching. This implies that embryonic Ca^{45} excreta are apparently recirculated. Ca^{45} is normally immobilized to a large extent in the yolk sac. The complexing agents prevent this immobilization. Femur Ca^{45} in 4-week-old chicks fed the complexing agent at 0.1 percent in the diet was increased 3 hours after injection, but no difference could be found at 24 hours. Blood Ca^{45} was increased by EDTA 3 hours after injection, but decreased at 24 hours. Excreta activity was greatest at 3 hours, and all treated groups excreted more Ca^{45} than the controls. In no case was bone ash altered by treatment with the complexing agents.

859. McCHESNEY, E. W. Effects of long-term feeding of sulfonic ion exchange resin on the growth and mineral metabolism of rats. *Amer. Jour. Physiol.* 177: 395-400. 1954.

"Rats weighing initially 220-250 g. were fed diets contg. 5-15% of sulfonic ion-exchange resin; their growth rates and life spans were compared to those of control animals receiving no resin. Fifteen % resin in the diet shortened the life span, and severely restricted growth, but 5 or 10% resin had no apparent effect on either. Animals receiving 15% resin were absorbing substantially no Na or K, but they continued to excrete small amts. in the urine. Animals receiving 10% resin excreted about 90% of the dietary Na in the feces. At the 10% dietary level the most Na and K were removed per.g. of resin ingested, while Ca and Mg were significantly increased in the feces only at the 5% dietary level. Resin feeding did not significantly increase fecal Fe, but it did markedly shift phosphate from feces to urine. The total uptake of cations by the resin is estd. as about 3 meq./g." (*Chem. Abs.* 48: 10868.)

860. PILEGGI, V. J., and others. Citrate in the prevention of rickets in rats. *Arch. Biochem. and Biophys.* 60: 52-57. 1956.

H. F. De Luca, J. W. Cramer, and H. Steenbock, joint authors.

"In young rats the antirachitic effect of the addn. of a mixt. of citric acid and Na citrate to a noncereal, high-Ca, phytate-contg. ration is attributable to an increase in the hydrolysis of phytic acid. Since the addn. of citrate decreased the demonstrable phytase content of the intestinal ext. its effect apparently was induced by a reduction in the inhibiting effect of Ca on phytic acid hydrolysis. An antirachitic effect of citrate was also demonstrable with a mildly rachitogenic ration in which the P was inorg." (*Chem. Abs.* 50: 6611.)

861. SALVINI, M. Efficacy of disodium monocalcium ethylenediaminetetraacetate in the urinary elimination of lead in the treatment of poisoning with lead acetate. *Bol. della Soc. Ital. di Biol. Sper.* 33: 409-410. 1957.

"The therapeutic action of Na_2Ca ethylenediaminetetraacetate (I) in the treatment of saturnism is attributable to chelation between Pb and I. I produced an immediate increase in the level of urinary Pb." (*Chem. Abs.* 52: 3161.)

862. SCHREIER, K., and OSTHELDER, G. Studien zum calciumstoffwechsel mit Ca^{45} . III. Untersuchungen uber den einfluss des phytins auf den calciumstoffwechsel. *Ztschr. f. die Gesam. Expt. Med.* 128: 136-139. 1956.

863. SCHREIER, K., and SCHNEPF, E. Studies on calcium metabolism with Ca^{45} . 1. Effect of citric acid and tartaric acid on calcium metabolism. *Ztschr. f. die Gesam. Expt. Med.* 127: 508-516. 1956.

"1. Experiments on normal and rachitic rats which were given 51.1 mg. CaCl_2 labelled with Ca^{45} showed that sodium citrate, in amounts as low as 4 mg. per animal, led to a statistically significant increase in the absorption and retention of Ca^{45} . In the rachitic animals the influence of citrate on Ca metabolism was even greater than in normal animals. Sodium tartrate also significantly increased the uptake of Ca and incorporation into bones and teeth. For maximum incorporation of Ca into the bones some phosphate was necessary. A salt mixture which contained 7 parts calcium citrate to 1 part calcium phosphate gave especially good absorption and retention of Ca^{45} , better than Ca citrate alone, or a mixture of calcium citrate and potassium phosphate with considerably higher phosphate content." (*Nutr. Abs. and Rev.* 27: 2195.)

864. SCHUBERT, J., and WALLACE, H., JR. Effect of zirconium and sodium citrate on the distribution and excretion of simultaneously injected thorium and radiostrontium. *Jour. Biol. Chem.* 183: 157-166. 1950.

"The distribution and daily excretion of tracer levels of injected Th and Sr were studied in rats receiving Zr citrate or Na citrate intraperitoneally 0.5 hr. after the administration of radio elements ("early" treated) or 3 days later ("late" treated). One group of rats received no other treatment. In contrast to previous studies on Pu and Y,

Zr citrate had no specific effect on Th or Sr metabolism other than that assoc. with the citrate part of the mol. The early administration of Zr citrate of Na citrate resulted in a 3-fold increase in the urinary excretion of Th, and a 2-fold increase in the urinary excretion of Sr during the following 24 hrs. No effect on the fecal excretion was found. The Th concn. in the liver, mesenteric lymph node, pancreas, and spleen was markedly reduced as a result of early Na citrate administration. No significant changes in the metabolism of Th or Sr were found in the late-treated groups. The deposition of Th/g was highest in the soft tissues, particularly in the liver, while Sr accumulated mainly in the skeleton. An interpretation of the results in terms of ion exchange, surface absorption, and complex formation is presented." (Chem. Abs. 44: 6034.)

865. TADDEI, I. Distribution of calcium between oxalate and citrate; experiments in vitro and in vivo. *Atti dell' Accad. dei Fisiocritici Siena, Sez. Med.-Fis.* 3: 318-356. 1956.

866. TAHA, M. M. Phytic acid distribution in food-stuffs; its relation to calcium and total phosphorus. *Jour. Egypt. Med. Assoc.* 37: 629-637. 1954.

MISCELLANEOUS FACTORS

867. BROWN, W. O. Effect of dietary penicillin on calcium and nitrogen retention in chicks on a low mineral diet. *Jour. Sci. Food and Agr.* 8: 279-282. 1957.

"Live-wt. increase, Ca and N retention, and serum Ca levels were detd. in chicks receiving a low-Ca diet, with and without added penicillin (I). Inclusion of I in the diet resulted in a small but significant (5% level) increase in Ca retention. The mean Ca level in the serum was also slightly increased by the I treatment. The N-balance data were relatively variable, and though the mean N retention of the chicks fed I was greater than that of the controls, this difference was not significant. The results supported the view that I addn. to a low-Ca diet of a chick results in increased absorption of Ca and an over-all increase in live wt." (Chem. Abs. 51: 12258.)

868. CALVERLEY, C. E., and KENNEDY, C. Effect of fat on calcium and phosphorus metabolism in normal growing rats under a normal dietary regime. *Jour. Nutr.* 38: 165-175. 1949.

"The inclusion of 5% fat (completely hydrogenated cottonseed oil, coconut oil, or peanut oil) increased the fecal excretion of Ca. When fats contg. many of the poorly absorbed glycerides of the long-chain, satd. acids were fed, the increase in fecal excretion was probably due to the formation of relatively insol. Ca soaps. When this was the case, the excretion of P in the feces was not increased. When fats contg. mostly the more rapidly absorbed glycerides of long-chain, un-satd. or short-chain, satd. fatty acids were fed, the increase in fecal excretion of Ca was reduced. It did not seem to be due to the formation of Ca soaps and it apparently carried P with it, since fecal P was also increased. The excretion of Ca and P in the urine was affected only indirectly by the presence of fat in the diet. When the fecal excretion of Ca was considerably increased there was a decrease in the urinary excretion of Ca but a marked increase in the urinary excretion of P. The cumulative result of the inclusion of 5% fat in the diet was a decrease in the retentions of Ca and P which roughly paralleled the increase in the fecal excretion of Ca. The inclusion of 5% fat in the normal diet, well supplied with Ca and P and having an optimum Ca:P ratio, did not apparently affect the formation of bone in healthy, growing rats." (Chem. Abs. 49: 7558.)

869. CHITIL, W., and KLARE, V. Ultraviolet radiation and its effect on the calcium content of bones. *Wien. Med. Wchnschr.* 105: 136-137. 1955.

870. D'AGOSTINO BARBARO, A., and ZANNELLI, C. [Calcium content of the blood and bones of rats fed

exclusively on milk.] *Bol. della Soc. Ital. di Biol. Sper.* 32: 1373-1375. 1956.

"Rats a few days after weaning were divided into an experimental group of 12 fed only on milk and a control group of 6 on mixed diet. The development of anaemia was studied and the rats were killed after 10 months. The experimental group began to show low red cell counts and low Hb after 2 months. At the end their mean serum Ca was 10 mg. per cent., range 8.4 to 12.2, against 10.5, 9.2 to 12.2, in the controls. Corresponding values for the Ca content of the tibia were 25.5 per cent., 22.8 to 27, and 25.7 per cent., 23.5 to 26.8. There was no significant difference." (Nutr. Abs. and Rev. 27: 5289.)

871. [No reference.]

872. FOURNIER, P. New insight on the physiology of the glucides, deduced from their different activity in regard to the utilization of calcium. *Acad. des Sci. Paris, Compt. Rend.* 239: 718-720. 1954.

"In a diet containing 12-20% sugar and 30-42 mg. Ca the following amt. of Ca was retained by the rats: sucrose, glucose, and maltose 26-37%; lactose 68; D-xylose 72; L-xylose 57.5; D-arabinose 44; and L-arabinose 63%." (Chem. Abs. 49: 3338.)

873. FOURNIER, P. Protective effect of milk against bone resorption in the lactating rat. *Acad. des Sci. Paris, Compt. Rend.* 238: 391-393. 1954.

"Addition of milk to the diet brings Ca balance into equilibrium, thus avoiding resorption of Ca from the maternal skeleton. This protective effect does not appear to be due to a special factor but to the protein and carbohydrate constituents of milk." (*Excerpta Med.* 8: 1280.)

874. FOURNIER, P. Metabolic action of sugars which influence the utilization of calcium. *Acad. des Sci. Paris, Compt. Rend.* 240: 115-117. 1955.

"Glucose, maltose, sucrose, lactose, galactose, D-xylose and L-arabinose are completely fermented by heavy inoculations of organisms from the cecum or large intestine of the rat. Ossification is thus favored by the accompanying increased utilization of dietary Ca. L-xylose is not completely fermented, and D-arabinose only to the extent of 8%. It is suggested that L-xylose and lactose act to increase Ca utilization by a direct metabolic effect favoring ossification. The same mechanism may apply to the other sugars." (Chem. Abs. 49: 7082.)

875. FOURNIER, P. Relations between the utilization of structural carbohydrates and ossification. *Acad. des Sci. Paris, Compt. Rend.* 240: 1364-1366. 1955.

"A diet consisting of starch 81.5, casein 4, peanut oil 8, dry yeast 3, salt mixt. 3, and TiO₂ 0.5% was fed to a control group of 50-g. rats. In other groups, incorporation into this diet, in place of an equiv. amt. of starch, of either D-xylose 3.5, mannose 10, lactose 7.6, melibiose 7.6, or raffinose 11.2%, resp., approx. doubled the utilization of Ca (Ca retained/Ca ingested) with reference to the control. These sugars are, therefore, included among the structural carbohydrates. Galactose had only a slight effect. It is postulated that, in contrast with the energy producing sugars, structural carbohydrates assist in ossification as precursors of glycine in the synthesis of ossein." (Chem. Abs. 49: 13388.)

876. FOURNIER, P., DUPUIS, Y., and SUSBIELLE, H. Action of sorbitol and mannitol on ossification. *Soc. de Biol. [Paris] Compt. Rend.* 149: 945-948. 1955.

"With growing rats on a high-starch, low-protein diet, inclusion of 6% of sorbitol, mannitol, or mannose in the ration markedly increased the retention of dietary Ca." (Chem. Abs. 50: 5869.)

877. FOURNIER, P., DUPUIS, Y., SUSBIELLE, H. Effects of dulcitol and mucic acid on calcium metabolism. *Soc. de Biol. [Paris] Compt. Rend.* 149: 1168-1170. 1955.

"The addition of 6% of dulcitol to the basic diet appreciably increased the retention of dietary calcium, while 6% of mucic acid almost completely prevented absorption of Ca from the digestive tract." (Chem. Abs. 50: 5868.)

878. FOURNIER, P., and others. Influence of the nature of dietary glucides on calcium utilization. Jour. de Physiol. 47: 339-350. 1955.

Y. Dupuis, H. Susbielle, M. Allez, and N. Tardy, joint authors.

"Rats, 5-6 weeks old, were fed a basal diet contg. starch 85.5, peanut oil 8, dry yeast 3, inorg. salts 3, and Ti oxide 0.5%. Ti oxide permitted the evaluation of the coeff. of absorption of Ca (cf. C.A. 45, 391g). Other diets were fed in which part of the starch was substituted by various mono- and disaccharides. Daily food intake was noted, and the corresponding excretion of Ca and glucide in the urine and feces was detd. Starch, maltose, glucose, and sucrose had no effect on Ca utilization; lactose, galactose, D- and L-xylose, and D- and L-arabinose increased the utilization of Ca. The B isomers of galactose and D-xylose were the most active." (Chem. Abs. 49: 14939.)

879. FOURNIER, P., and others. Mode of action of structural glucides on calcium utilization. Jour. de Physiol. 47: 351-362. 1955.

Y. Dupuis, H. Susbielle, M. Allez, and N. Tardy, joint authors.

"Glucose, maltose, sucrose, and lactose were easily fermented by intestinal bacteria *in vitro*. D-Galactose, D-xylose, and L-arabinose were less easily fermented, and D-arabinose was almost unfermentable. L-xylose was not utilized aerobically or anaerobically, by the bacteria. This glucide is especially active in increasing the utilization of Ca; its mode of action is probably by a direct metabolic pathway." (Chem. Abs. 49: 1493.)

880. FOURNIER, P., SUSBIELLE, H., and DUPUIS, Y. Osteogenic action of glyicides, of hexa-alcohol, and of glycolic acid; recent data on physiology of glyicides. Jour. de Physiol. 47: 793-806. 1955.

881. FOX, B. W., and others. Effect of intragastric irradiation on gastric acidity in the dog. Gastroenterology 24: 517-534. 1953.

A. Littman, M. I. Grossman, and A. C. Ivy, joint authors.

"Radioapplicators for intragastric irradiation were prepared from solid materials, which, unlike liquid materials, may be kept under control at all times. Sources of radiation included Ra needles, Ru¹⁰⁶-Rh¹⁰⁶, and Sr⁹⁰. Design of the applicators and dose estimations are given. Dogs were exposed to dosage ranges from ineffective to lethal. Results are tabulated for each radioactive source used. For each agent a dosage range was observed in which significant reduction of gastric acidity occurred, lasting from 2 to 6 months. Possible therapeutic applications in gastric ulcer are discussed." (Author's summary.)

882. FRANDSEN, A. M., and others. The effects of various levels of dietary protein on skeletal growth and endochondral ossification in young rats. Anat. Record 119: 247-265. 1954.

M. M. Nelson, E. Sulon, H. Becks, and H. M. Evans, joint authors.

"The effects of skeletal growth and endochondral ossification of varying degrees of protein deprivation were studied in young male rats. Purified diets containing 6%, 3% or 0% casein were given for 6-6½ weeks. The control purified diet containing 24% casein was given *ad libitum* or in restricted amounts for pair-fed controls corresponding to each group of protein-deficient animals. Skeletal growth and endochondral ossification were strikingly decreased by low protein intake, resulting either from a low level of dietary protein or from a decreased intake of diets containing a normal protein level. Invariably the protein-deficient animals were more severely affected than corresponding pair-fed controls. Histologic studies of the proximal tibial epiphysis revealed the following changes which were again more severe in deficient animals than in pair-fed controls: Decrease in width of the epiphyseal cartilage plate due to diminished number and size of cartilage cells, increase in cartilage ground

substance, slowing down and final arrest of cartilage erosion, resulting in fewer and coarser bone trabeculae. Variable amounts of fat in the bone marrow were noted. The most extreme changes were shown by animals on the protein-free diet which exhibited "sealing-off" bone and the virtual absence of fat cells in the marrow." (Biol. Abs. 29: 11318.)

883. FUSE, S., and KAMBE, Y. Local effects of drugs on dentine calcification. Gunma Jour. Med. Sci. (Japan) 6: 43-47. 1957.

"Drugs used to study the local effects on the calcification of dentine of teeth were found to fall into 4 groups: (1) Drugs producing an accelerative effect, such as Ca lactate; (2) drugs producing an inhibitor effect, such as NaF, MgSO₄, quinine-HCL, and procaine-HCL; (3) drugs producing both an accelerative and an inhibitory effect, such as morphine-HCL and caffeine; and (4) drugs producing no effect, such as testosterone and estrogen. These conclusions were obtained by decalcifying teeth and staining with hematoxylin. The state of calcification was detd. from the intensity of the stain." (Chem. Abs. 52: 1481.)

884. HARRIS, A., and SCHUBERT, M. Inhibition of calcification *in vitro* by luteocobalti chloride. Soc. Expt. Biol. and Med. Proc. 90: 714-717. 1955.

"When tibial sections are exposed to the action of luteocobalti chloride, calcification is inhibited. This inhibition is antagonized by Ca⁺⁺ which prevent the luteocobalti cation from depositing on the surface of the epiphyseal plate. Tibial sections which have been exposed to trypsin can no longer bind luteocobalti chloride." (Internatl. Abs. Biol. Sci. 4: 5884.)

885. HARTSOOK, E. W. Effect of chlortetracycline (aureomycin) upon calcium retention by growing albino rat. Jour. Nutr. 60: 97-104. 1956.

"With a diet containing adequate amounts of vitamin D, aureomycin did not increase Ca retention, wt. gain, body length or body water % in male weanling rats. Aureomycin increased the gain in body ether extract % and decreased the gain in body dry wt." (Internatl. Abs. Biol. Sci. 6: 2588.)

886. HOEKSTRA, W. G., and others. Relationship of parakeratosis, supplemental calcium and zinc to the zinc content of certain body components of swine. Jour. Anim. Sci. 15: 752-764. 1956.

P. K. Lewis, Jr., P. H. Phillips, and R. H. Grummer, joint authors.

"Addition of Zn (50 p.p.m.) as ZnSO₄ to pig rations greatly relieved parakeratosis and increased the Zn contents of the blood-plasma, liver, and kidneys but not that of packed r.b.c., spleen, intestines or pancreas. A further addition of bone meal (2 %) to the ration lowered the Zn concn. in liver and kidneys but did not alter that in r.b.c., spleen, intestine or pancreas." (Internatl. Abs. Biol. Sci. 7: 609.)

887. INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1955. Biological effects of radiation. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy Held in Geneva 8 August-20 August 1955. V. 11, 402 p. New York, United Nations, 1956.

888. JONAS, H., and GOURLEY, D. R. H. Effect of adenosine triphosphate, magnesium, and calcium on the phosphate uptake by rabbit erythrocytes. Biochim. et Biophys. Acta 14: 335-345. 1954.

"ATP stimulates the *in vitro* uptake of P³²-labelled orthophosphate by rabbit erythrocytes. Phosphate uptake is inhibited by Ca⁺⁺ and Mg⁺⁺ when these ions and phosphate are present in approx. equal concns. With Mg⁺⁺, stimulation occurs when the ATP concn. is either greater or less than the ion concn. The results are discussed with reference to the effects of ATP on the soly. of bivalent alk. metal phosphates and possible inter-actions in an ATP-Mg phosphate system." (Chem. Abs. 48: 12994.)

889. KOGAN, A. M., and ERSHOVA, O. A. Biochemical variations of the bone in animals in experimental alimentary mycotoxicosis. *Voprosy Pitaniya* 2: 56-57. 1956.

"In the bones of young dogs and rats, which have received cultures of *Fusarium sporotrichiella*, there is a large amount of water, a little mineral salt (in the form of Ca and P) and a little fat. The phosphatase activity in these bones is shown to be increased. It is suggested that changes in bones in experimental mycotoxicosis have much in common with those in Kashin-Baker disease." [Russian.] (*Internatl. Abs. Biol. Sci.* 7: 615.)

890. KOZLOVSKII, V. S. The effect of lymphoid tissue upon calcium metabolism. *Byul. Eksper. Biol. i Med.* 38: 42-44. 1954.

"In previous investigations it was established that exts. obtained from lymph nodes affect the Ca content of the skin, muscles, and serum. A similar observation was made while studying the effect of the ext. upon the Ca of the xiphoid cartilage and the compact mass of femur. Rabbits with normal serum Ca were used as test animals. Following the ext. injection the cartilage Ca increased 13.1%, that of the femur only 1%. The ext. also affected the Ca of splenectomized animals, causing an increase of 27% in the xiphoid cartilage and 7.3% in the femur. A callus formed after exptl. noncomplicated fracture of the anterior extremities contained 20% more Ca than the bones of controls." (*Chem. Abs.* 49: 6421.)

891. LEMAIRE, R., and others. Variations in blood calcium during states of mixed dehydration. *Soc. de Biol. [Paris] Rend. Compt.* 150: 684-688. 1956.

G. Pille, H. Ducros, and P. Palancade, joint authors.

"Horses were given dry feed and no water for 3 days and exercised to induce profuse sweating. The extracellular fluid showed an av. 13% increase in Ca concn., but because of the decrease in total vol. of extracellular fluid (interstitial fluid plus plasma) the total stock of extracellular Ca showed a 10% decrease." (*Chem. Abs.* 51: 572.)

892. LIKINS, R. C., BAVETTA, L. A., and POSNER, A. S. Calcification in lysine deficiency. *Arch. Biochem. and Biophys.* 70: 401-412. 1957.

"Ca metabolism, surface chemistry, and crystal structure of the bone of normal and lysine-deficient rats are described. A dietary-lysine deficiency was assoc. with a decrease in the skeletal deposition of Ca^{45} due, in part at least, to a failure in bone growth. The probable mechanisms of Ca^{45} fixation under these conditions are discussed." (*Chem. Abs.* 51: 18175.)

893. LUECKE, R. W., and others. Calcium and zinc in parakeratosis of swine. *Jour. Anim. Sci.* 16: 3-11. 1957.

J. A. Hoefler, W. S. Brammel, and D. A. Schmidt, joint authors.

"Two expts. including 10 lots of 10 pigs each are reported. A ration with 0.65% Ca, 0.53% P, and 45 p.p.m. Zn gave good growth but 10% incidence of parakeratosis. Poor growth and 100% incidence of parakeratosis was obtained with 1.25% Ca, 0.95% P, and 40 p.p.m. Zn. In expt. II, 0.51% Ca, 0.61% P, and 32 p.p.m. Zn gave depressed growth and 40% parakeratosis. Severely depressed growth and 100% incidence of parakeratosis resulted from a ration contg. 1.21% Ca, 0.61% P and 29 p.p.m. Zn or 1.90% Ca, 0.61% P, and 31 p.p.m. Zn. Supplementation of all rations with 50 p.p.m. Zn (as ZnCO_3) increased growth, improved feed efficiency, and prevented symptoms of parakeratosis. Preliminary studies indicated Zn increased serum alk. phosphatase activity." (*Chem. Abs.* 51: 7545.)

894. MAIOLI, M. I. Calcium-phosphorus balance one month after the operation. *Arcispedale S. Anna di Ferrara* 9: 665-671. 1956.

"The study of the Ca and P metabolism in 10 gastrectomized patients fed a standard diet contg. the daily need of Ca and P, showed a small deficit." (*Chem. Abs.* 52: 2243.)

895. MARKS, P. A., and SHORR, E. Evaluating the relation of glycogen to inorganic salt deposition in surviving cartilage slices *in vitro*. *Science* 112: 752-754. 1950.

"A method is described by which a direct correlation can be made in the same cartilage slice between the glycogen zone and the area of subsequent lime salt deposition. By means of this technique a close correlation was found between the glycogen-contg. area and the region in which both Ca and Sr were deposited after incubation *in vitro* and it was evident that removal of glycogen from cartilage prior to its exposure to Ca or Sr ions interfered with the deposition of these cations." (*Chem. Abs.* 45: 3011.)

896. MATHER, G. Calcium metabolism and bone changes in sarcoidosis. *Brit. Med. Jour.* i: 248-253. 1957.

From more than 160 subjects, in many of whom mass radiography had detected abnormalities that were investigated further and in whom sarcoidosis had been diagnosed, X-ray photographs were taken of hands and feet of 120. Bone changes appeared in only 9. Of 86 untreated and in whose blood Ca was estimated, only 4 had more than 11 mg. per 100 ml. serum. Although the level was high in only a few patients with sarcoidosis, there might be renal damage if such patients were treated with vitamin D.

897. MATSUDA, N. Effect of a mandibular gland extract upon development and calcification pattern of rabbit dentine and bone. II. Synergic action between parotid and mandibular gland extracts. *Gunma Jour. Med. Sci. (Japan)* 5: 159-166. 1956.

"Nearly simultaneous injection of 0.5 mg. parotin (I) and 0.1 mg. mandibular gland ext. (II), which separately are ineffective at this dose, into 10 rabbits decreased longitudinal and lateral growth of the dentine and serum Ca. Bone growth was doubled in 4 days. The effects were similar to those caused by 1 mg. I or 1-3 mg. II alone/kg. Also simultaneous doses of 0.25 mg. I and 0.05 mg. II/kg. had a similar effect in 4 of 6 rabbits. It is believed that the mechanism of action of I and II is different, though the effects are similar." (*Chem. Abs.* 51: 6802.)

898. NITTA, H., and ANDO, S. On the nitrogenous substances in the parotid gland of the rabbit. *Nagoya Med. Jour.* 3: 127-140. 1956.

"The parotid and submaxillary glands of rabbits were homogenized in H_2O and the soln. was adjusted to 10% concn. of CCl_3COOH . The filtrate (I) was adjusted to pH 4-5 and alc. added to obtain a concn. of 80%. The ppt. (II) was then injected into controls and rabbits whose parotid glands were removed. The decrease in serum Ca was greater in the exptl. than the control animals. The decreases were due to changes in protein and citrate Ca since the Ca^{++} remained const. Variations in blood sugar, blood pressure, and respiration were not significant. II was found to contain cystine, lysine, aspartic acid, glutamic acid, arginine, serine, proline, tyrosine, histidine, tryptophan, methionine, phenylalanine, leucine, and glycine after hydrolysis with 20% HCl. The concn. of $(\text{NH}_4)_2\text{SO}_4$ (III) in I was adjusted to 30%. The resulting ppt. (IV) was dissolved in phosphate buffer, pH 7.0. This soln. had an absorption max. at 275 and a min. at 255 μ and had 2 peaks when subjected to electrophoresis. It produced a greater decrease in serum Ca in the exptl. than in the control rabbits. Using different concns. of III, IV was found to be composed of 2 fractions. One fraction was pptd. by 15-17 and the other by 28-30% III. The first fraction had an absorption max. at 274 μ and was homogenous upon electrophoresis. The 2nd fraction had an absorption max. at 272 μ and showed 2 peaks upon electrophoresis. Both fractions were examd. in phosphate buffer, pH 7.0. Upon injection into animals, both fractions decreased serum Ca and protein N but had no effect on blood sugar and pressure, or respiration. It is suggested that these substances might be related to parotin isolated by Ogata, et al. (*Igakusoho* 1, 301 (1946))." (*Chem. Abs.* 51: 18209.)

899. PATRICK, H., and SCHWEITZER, G. K. Factors associated with the movement of calcium from the

food to the bones of chicks. *Poultry Sci.* 33: 1199-1201. 1954.

"A water-soluble factor that can be destroyed by dialysis and that is found in milk albumin and casein increases bone mineralization in chicks as measured by Ca^{45} deposition." (Author's abstract.)

900. REISFELD, R. A. Calcium-binding properties of whole casein, α -casein, and β -casein. Univ. Microfilms Pub. 21494, 152 pp. 1957.

901. SEALANDER, J. A., JR. Influence of temperature stress on uptake of P^{32} in the rat. *Amer. Jour. Physiol.* 186: 227-230. 1956.

"Ten adult rats were kept in a hot room at $35 \pm 1.5^\circ \text{C}$. for 10, 23 or 30 days, 11 rats in a cold room at $2^\circ \pm 1.5^\circ \text{C}$. for 10, 23 or 29 days and 5 at normal temperature of about 26.5°C . for a month. Each rat received a single intraperitoneal injection of about $20 \mu\text{c}$. P^{32} and H_3PO_4 48 hr. before being killed. Distribution of P^{32} in the tissues was studied. In rats exposed to cold less P^{32} was found in bone, adrenals and liver and more in brown fat than in controls kept at normal room temperature. In rats exposed to heat more P^{32} was found in bone, adrenals and liver after 23 days, but there was no other significant difference from control values." (*Nutr. Abs. and Rev.* 22: 2203.)

902. SENDA, H. The influence of the intravenous injection of chlorides on the blood and urine. *Mitt. aus der Med. Akad. Kyoto* 25: 707. 1939.

"Estn. of the Cl content of the blood and urine of rabbits after the intravenous injection of 2.0 cc./kg. of N NaCl, LiCl, RbCl₂ and SrCl₂ revealed that the bivalent chlorides were excreted more rapidly than the univalent chlorides." (*Chem. Abs.* 35: 1117.)

903. SWELL, L., and others. Effect of dietary fat and fatty acid on fecal excretion of a calcium oleate phosphate complex. *Soc. Expt. Biol. and Med. Proc.* 92: 613-615. 1956.

E. C. Trout, Jr., H. Field, Jr., and C. R. Treadwell, joint authors.

"Excretion of a calcium oleate-phosphate lipid complex in the feces of rats was studied under various dietary conditions. Diets containing 25% of either olive oil, corn oil, hydrogenated soybean oil, palmitic acid or oleic acid were compared with a fat-free basal diet. Oleic acid was approximately 70 times more effective in stimulating formation of lipid than either corn oil or olive oil. Palmitic acid had a very slight effect, whereas hydrogenated soybean oil had no effect. Absorption of oleic acid was much lower than that of palmitic acid, corn oil, or olive oil, perhaps due to the formation of the lipid. The significance of the fecal lipid is discussed." (*Biol. Abs.* 31: 851.)

904. VASIL'eva, E. N. Effect of the quantity and quality of fat in the ration on the calcium utilization by growing animals. *Voprosy Pitaniya* 15 (6): 11-16. 1956.

"One month old white rats were fed 4 isocaloric synthetic diets contg. 18 cal. % casein and different amts. of fat (5, 20, 40, and 60 cal. % of sunflower oil or beef fat). The balance of the feed was then adjusted by addn. of 73 (?), 62, 42, and 22 cal. % carbohydrates, resp. The amts. of salts and vitamins were the same for all diets. The diet contg. 20% fat, 18% casein, and 62% carbohydrates was the control diet. The results obtained on 112 rats indicate that the amt. of fat in the diet affects the Ca utilization by the growing rats. The greatest utilization of the dietary Ca (66.8-74.28%) was observed when the rats received the diet contg. 20% fat; in this diet the Ca allowance was 0.05 g. Ca/g. fat. Accumulation of Ca and P in bones was the greatest when the diets contained 5 or 20% fat: after 30-day feeding of the diets the amt. of dietary Ca retained in the femur bones was 21.28 ± 0.28 (by feeding 20% sunflower oil) and 21.67 ± 0.45 (by feeding 20% beef fat) in the epiphysis and 26.51 ± 0.34 and 26.03

$\pm 0.37\%$ in the diaphysis part of the bones, resp. The corresponding P retention in the bones for the 20%-fat diet was 9.82 ± 0.11 and 11.99 ± 0.16 (epiphysis) and 9.95 ± 0.15 and $11.84 \pm 0.14\%$ (diaphysis) of the dietary P resp. The retention of Ca and P in the bones was greatly decreased by feeding the diets contg. 40 or 60% fat. The presence of unsatd. fatty acids in the fat (sunflower oil) did not show any addnl. effect on the utilization of the dietary Ca by growing young animals as compared with the fat contg. mainly satd. fatty acid (beef fat)." (*Chem. Abs.* 51: 5942.)

905. WASSERMAN, R. H., and others. Interrelated effects of L-lysine and other dietary factors on the gastrointestinal absorption of calcium-45 in the rat and chick. *Jour. Nutr.* 62: 367-376. 1957.

C. L. Comar, J. C. Schooley, and F. W. Lengemann, joint authors.

"Proportionally more of the absorbed Ca^{45} was found in the femurs of the vitamin D-supplemental rat than in the vitamin D-deficient rat. Vitamin D had no apparent effect on the deposition of absorbed Ca^{45} in the tibias of the rachitic chick." (*Chem. Abs.* 51: 18163.)

906. WIETEK, F., and TAUPITZ, E. Influence of lyophilized placenta on the experimental arteriosclerosis of rats. *Arzneimittel-Forsch.* 7: 479-485. 1957.

"Female $1\frac{1}{2}$ year-old rats were fed with a sclerosis-producing diet consisting of oats, hydrogenated fat, cholesterol, and vitamin D₃ for 80 days. The animals lost considerable wt. and showed erythropenia and leucocytosis. Total serum cholesterol, phospholipides, and β -globulins were reduced; α -globulins increased. Total cholesterol in liver, suprarenals, kidneys, and lungs increased. The wt. of the aorta more than doubled, Ca in kidneys increased 3-fold, and Ca in the aorta 100-fold. Intramuscular application of lyophilized sheep placenta caused a marked reduction of Ca in kidneys and aorta; it increased serum cholesterol and phospholipide levels. Oral feeding of the placenta prepn. had no effect." (*Chem. Abs.* 52: 559.)

907. ZHIZHINA, N. A. Distribution of calcium-45 in calcified tissues of rats under various nervous influences. *Moskov. Med. Stomatol. Inst. Nauch. Raboty* 1, p. 40-48. 1955.

"After injecting normal rats with Ca^{45} the isotope is found in greatest quantity in the bones followed by the canine teeth, and finally the molars. For the bones the max. absorption is found after 18 hrs.; for the teeth after 24-26 hr. After paranephral blocking by novacaine the degree of uptake of the isotope into the femurs and teeth was lowered, but the max. was attained in the 12th hour. On the 14th day after cutting of the sciatic nerve the level of uptake of the Ca^{45} was raised, but the max. shifted to 24 hr." (*Internat. Abs. Biol. Sci.* 6: 2590.)

908. ZITTLE, C. A., and others. Binding of calcium ions by β -lactoglobulin both before and after aggregation by heating in the presence of calcium ions. *Jour. Amer. Chem. Soc.* 79: 4661-4666. 1957.

E. S. DellaMonica, R. K. Rudd, and J. H. Custer, joint authors.

"Heating β -lactoglobulin in the presence of Ca ions results in aggregation, but does not affect the amt. of Ca bound in the pH region 6.2-7.5. In the heated Ca-contg. solns. aggregation is detd. by the net charge on the protein resulting from binding of Ca ions and is analogous to isoelec. aggregation. Thus, isoelec. pptn. of heated β -lactoglobulin solns. can be obtained by lowering the pH to the isoelec. region or at a const. alk. pH by the addn. of Ca. Although the Ca in the aggregated, heated β -lactoglobulin is physically less accessible, it is in equil. with the Ca in soln. and can be removed by suitable procedures. The amt. of Ca bound to β -lactoglobulin is equiv. to the net neg. charge in the pH range 6-8." (*Chem. Abs.* 51: 18048.)

THE FALLOUT PROBLEM

GENERAL

909. BERGH, H., and others. Radiochemical analysis of fallout in Norway. Norwegian Defense Res. Estab. Rpt. KIR-175/57, 6 p. 1957.

G. Finstad, L. Lund, O. Michelsen, and B. Ottar, joint authors.

910. BERGH, H., and others. Radiochemical analysis of fallout in Norway. Norwegian Defense Res. Estab. Rpt. KIR-177/57, 4 p. 1957.

G. Finstad, L. Lund, O. Michelsen, and B. Ottar, joint authors.

911. BERGH, H., and others. Radiochemical analysis of fallout in Norway. Norwegian Defense Res. Estab. Rpt. KIR-183/57, 7 p. 1957.

G. Finstad, L. Lund, O. Michelsen, and B. Ottar, joint authors.

912. BERGH, H., and others. Radiochemical analysis of fallout in Norway. Norwegian Defense Res. Estab. Div. K Rpt. KIR-186/57, 6 p. 1957.

G. Finstad, L. Lund, O. Michelsen, and B. Ottar, joint authors.

913. BOOKER, D. V., and others. Radiostrontium and radiocaesium measurement in biological materials to December 1956. Atomic Energy Res. Estab. (Gt. Brit.) HP/R-2182, 11 p. 1957.

F. J. Bryant, A. C. Chamberlain, A. Morgan, and G. S. Spicer, joint authors.

"Data are presented on the Sr^{90} content of samples of soil, grass, milk, sheep bones, and human bones, and the Cs^{137} content of samples of milk collected in Great Britain during 1956. The trend of activity levels with time was examined, and it was found there was little increase in 1956 over 1955 except among samples derived from low calcium soil." (Nuclear Sci. Abs. 11: 5171.)

914. BOROUGHS, H., TOWNSLEY, S. J., and HIATT, R. W. Method for predicting amount of strontium-89 in marine fishes by external monitoring. Science 124: 1027-1028. 1956.

"In an attempt to save the time required for ashing, etc., pelagic fish of several species including Pacific yellowfin tuna (*Neothunnus macropodus*) were fed Sr^{90} and external monitoring of various body areas compared with conventional counting methods. Above a threshold level which would vary with the counting instrumentation used (between 0.16 and 0.40 microcuries), counts per min. from the caudal fin bore a straight-line relationship to microcuries of Sr^{90} in the skeleton." (Chem. Abs. 51: 5890.)

915. COHN, S. H., and others. Internal radioactive contamination of human beings accidentally exposed to radioactive fallout material. U.S. Nav. Radiol. Defense Lab., San Francisco, Calif., and U.S. Nav. Med. Res. Inst., Bethesda, Md., USNRDL-TR-86, 50 p. 1956.

R. W. Rinehart, J. S. Robertson, J. K. Gong, W. L. Milne, W. H. Chapman, and V. P. Bond, joint authors.

916. COMAR, C. L., and others. Thyroid radioactivity after nuclear weapons tests. Science 126: 16-18. 1957.

B. F. Trum, U. S. G. Kuhn III, R. H. Wasserman, M. M. Nold, and J. C. Schooley, joint authors.

"This paper summarizes the information that has been obtained on the levels of iodine 131 in human and cattle thyroids and presents an estimate of milk levels in the United States during the period from January 1955 to December 1956. Correlation with known bomb tests is noted, and some inferences are drawn about routes of exposure." (Author's summary.)

917. EISENBUD, M., and HARLEY, J. H. Radioactive fallout in the United States. Science 121: 677-680. 1955.

"A summary of data accumulated by the fallout monitoring network of the U.S. Atomic Energy Commission, including data obtained in the Pacific exercises in the fall of 1952, the Nevada tests of 1953, and the Pacific tests in the spring of 1954." (Author's summary.)

918. HARDY, E. P., JR. Summary report for February. U.S. Atomic Energy Comm. HASL-23, 58 p. 1958.

"Strontium 90 levels in fallout, milk, vegetation, and tap water are summarized for data available up to January 30, 1958. Original data submitted during January are included as an appendix." (Author's abstract.)

919. HARDY, E. P., JR. Summary report for March. U.S. Atomic Energy Comm. HASL-28, 4 p. 1958.

"Strontium 90 levels in fallout, milk, vegetation, and tap water are summarized for data available up to February 28, 1958. Original data submitted during February are included as an appendix." (Author's abstract.)

920. HARDY, E. P., JR. Summary report for April. U.S. Atomic Energy Comm. HASL-34, 68 p. 1958.

"Strontium 90 levels in fallout, milk, and tap water are summarized for data available up to April 5, 1958. Original data submitted during March are included as an appendix." (Author's abstract.)

921a. HARDY, E. P., JR. Summary report for May. U.S. Atomic Energy Comm. HASL-38, 84 p. 1958.

"Strontium 90 levels in fallout, milk, tap water, river water, and melted snow are summarized for data available up to May 1, 1958. Original data submitted during April are included as an appendix." (Author's abstract.)

921b. HARDY, E. P., JR. Summary report for June and July. U.S. Atomic Energy Comm. HASL-47, 91 p. 1958.

"Strontium 90 levels in fallout, milk, animal bone, tap water, sea water, and melted snow are summarized for data available up to July 28, 1958. Original data submitted during June and the first 2 weeks in July are included as an appendix." (Author's abstract.)

922. HARLEY, J. H., and others. Summary of analytical results from the Health and Safety Laboratory strontium program to June 1956. U.S. Atomic Energy Comm. NYO-4751 (rev.), 36 p. 1956.

E. P. Hardy, Jr., G. A. Welford, I. B. Whitney, and M. Eisenbud, joint authors.

923. HARLEY, J. H., and others. Summary of analytical results from the Health and Safety Laboratory strontium program July-December, 1956. U.S. Atomic Energy Comm. NYO-4862, 44 p. 1957.

E. P. Hardy, Jr., I. B. Whitney, and M. Eisenbud, joint authors.

924. HOARD, A. G., EISENBUD, M., and HARLEY, J. H. Annotated bibliography on long range effects of fallout from nuclear explosions. U.S. Atomic Energy Comm. NYO-4753 (sup. 1), 18 p. 1956.

"This bibliography is limited to published articles and speeches concerning the various aspects of radiation effects resulting from fallout of nuclear explosions. Although some articles reflect instrumentation as used in respect to measuring the effects of fallout, no major attempt was made to include the field of instrumentations. See also NYO-4753." (Author's summary.)

925. MARTELL, E. A. Strontium-90 concentration data for biological materials, soils, waters and air filters. U.S. Atomic Energy Comm. AECD-3763, 62 p. 1955.

926. MARTELL, E. A. Strontium-90 concentration data for biological materials, soils, waters and air filters. U.S. Atomic Energy Comm. AECU-3297 (rev.), 67 p. 1956.

927. MEINKE, W. W. Radioactive snows at Ann Arbor, Michigan. *Science* 113: 545-546. 1951.

"Radioactive rare earth isotopes, Ba and (or) Sr isotopes, and possibly I isotopes were found in snow near Ann Arbor after Las Vegas at. test explosions of Jan. 27-Feb. 6, 1951." (Chem. Abs. 45: 8361.)

928. PATTERSON, R. L., JR., and BLIFFORD, I. H., JR. Atmospheric carbon-14. *Science* 126: 26-28. 1957.

"Because of extensive use of C^{14} dating, the increase of C^{14} in the atm. because of thermonuclear explosions was studied. CO_2 contg. C^{14} was drawn through NaOH, $CaCO_3$ was pptd., and CO_2 was liberated and converted to acetylene. The acetylene was used as a counting gas in a proportional counter. Measurements were made vs. acetylene obtained from contemporary C standards and $SrCO_3$ prepd. from fossil C. Samples taken in 1952 showed sample/standard ratios of C^{14} to be very similar in widely sepd. areas. After thermonuclear tests, it was shown that C^{14} concn. increased slower than that of other fission products. Collections made in Washington, D.C., from January 1955 to February 1956 showed as much as 18% higher C^{14} content, and it was assumed that this resulted from thermonuclear tests. Delayed increase of the C^{14} ground level indicated a stratospheric reservoir of this isotope." (Chem. Abs. 51: 15190.)

929. UNITED NATIONS SCIENTIFIC COMMITTEE. Report of the United Nations Scientific Committee on the effects of atomic radiation. Gen. Assembly Off. Rec. 13th Sess. sup. 17 (A/3838), 227 p. 1958.

This comprehensive report represents the thinking of 15 nations in regard to the effects of all modes of radiation exposure on the human population. This authoritative handbook covers the following subjects: General, physical data, fundamental radiobiology, somatic effects of radiation, and genetic effects of radiation.

930. U.S. ATOMIC ENERGY COMMISSION. Environmental contamination from weapons tests. U.S. Atomic Energy Comn. HASL-42D. 4 v. 1958.

This is an important and extensive compilation of data concerning transport, deposition, distribution, and biological uptake of worldwide radioactive fallout. Included are comprehensive review papers and bibliographies.

931. WOLFF, A. H. Radioactivity in animal thyroid glands. U.S. Pub. Health Rpts. 72: 1121-1126. 1957.

"Iodine-131 activity was readily found in thyroid glands from grazing animals in Arizona, Pennsylvania, Ohio, and Oregon within 2 weeks following the start of the 1956 U.S. Pacific at. weapons tests. A progressive increase was noted in the proportion of samples which were active from mid-May to mid-October, at which time the study was terminated. Based on the Arizona and Ohio data, the av. weekly dosages from mid-May to mid-October to cattle and sheep were 35 and 120 milliroentgen equiv. phys., resp., apparently harmless to the health of animals. It is suggested that the av. cattle I^{131} level found in this study is approx. the av. continuously existing in U.S. cattle during the past 2 or 3 years. Theoretical considerations indicate that the levels of I^{131} found in cattle thyroids, detectable amts. of I^{131} would have been secreted with the fresh milk produced in these areas." (Chem. Abs. 52: 5502.)

THEORETICAL ASPECTS

932. ANONYMOUS. Strontium-90 in man. *Brit. Med. Jour.* 5021: 752-753. 1957.

A short summary on the problem of assessing the hazards of strontium 90 in bone.

933. ANDERSON, E. C., and others. Radioactivity of people and foods. *Science* 125: 1273-1278. 1957.

R. L. Schuch, W. R. Fisher, and W. Langham, joint authors.

"Studies are being made to ascertain the effects of increased radioactivity levels in people and foods. It was proposed (Miller and Marinelli, *Science* 124: 122 (1956)) that Cs^{137} be used to follow postdetonation fallout and subsequent contamination in foods and people. The results of previous study were reported (Anderson, *Brit. J. Radiol.*, Suppl., 7: 27 (1956)). Data collected in 1956 are reported in this article. Measurements of the whole body Cs^{137}/K^{40} ratios of people were made. Peaks in radioactivity ratios were shown to coincide with nuclear tests. The same results were found for milk, and it was shown that the radioactivity levels of milk from different states were greater along the radioactive cloud path. Preliminary measurements of Cs^{137} found in foods other than milk are given. On the basis of the data gathered, it appears that milk contributes about 50% and meat about 25% of the Cs^{137} found in the body. However, it is stated that Cs^{137} from weapons testing and waste disposal is unlikely to be a serious hazard. The av. radiation dose is 1/20 of that received from natural radio-K. Because of the short 140-day biol. half-life of Cs^{137} , it does not accumulate in the body as does Sr^{90} ." (Chem. Abs. 51:15285.)

934. ANDREWS, H. L. Radioactive fallout from bomb clouds. *Science* 122: 453-456. 1955.

"General discussion of radioactive fallout in the vicinity of nuclear detonations, including mechanics of formation, amount of activity, etc. Discusses maximum permissible levels of gamma radiation for test series, estimates dosages near test site under certain assumptions. Discusses beta burn hazard and danger from retention of particles in lungs. Concludes only particles from 0.5 to 5 micron diameter are potentially hazardous to lungs, and fraction in this size range will be small. Also discusses long-lived fallout and potential hazard from $Sr-90$ and genetic effects. Concludes weapon testing program justified by defense effort and that radiological hazards have been minimized under the well-controlled conditions of weapon testing." (Chem. Abs. 50: 2306.)

935. BUGHER, J. C. Some considerations of strontium-90 in man's environment. *Mich. Univ. Med. Bul.* 22: 497-500. 1956.

936. CAMPBELL, C. Radiostrontium fallout from continuing nuclear tests. *Science* 124: 894-895. 1956.
An evaluation of the potential hazard from fallout Sr^{90} .

937. CASTER, W. O. Strontium-90 hazard: relation between maximum permissible concentration and population mean. *Science* 125: 1291-1292. 1957.

"The recently introduced M P C unit (1 microcurie of $Sr-90$ per kilogram of calcium) is discussed. Relations between the max. permissible concn. and the population mean are explained, and three factors; a safety factor, an allowance for children, and a heterogeneity factor are introduced. Because of the high $Sr-90$ accumulation rate in children, it is recommended that milk be decalcified to reduce $Sr-90$ intake." (Chem. Abs. 51: 15645.)

938. COHN, S. H., and others. Nature and extent of internal radioactive contamination of human beings exposed to fallout material in Operation Castle. *Radiation Res.* 3: 218-219. 1955.

R. W. Rinehart, J. K. Gong, J. S. Robertson, W. H. Chapman, and W. L. Milne, joint authors.

Exposure of human beings to significant internal contamination with fission products first occurred as a result of the ingestion and inhalation of fallout material from a nuclear detonation in the spring of 1954. The nature and extent of these internal radioelements excreted by the exposed human beings are evaluated, with data obtained from radiochemical analysis of the tissues and excreta of animals contaminated at the same time.

939. COPP, D. H., and KAWIN, B. Some considerations in fission product contamination. U.S. Atomic Energy Comn. ANL-5584, p. 123-129. 1956.

940. HESLEP, J. M., and BELLAMY, A. W. The recycling of fission products in the biotic cycle. *Jour. Chem. Ed.* 30: 421-424. 1953.

"A general discussion is presented of the problem of man's ingestion of radioactive elements via the soil-plant or the soil-plant-domestic animal route after radiological contamination of a land area. Pu and Sr are considered as probably the greatest hazards, although other radioisotopes are considered as possibilities. Such isotopes may become solubilized into the soil and adsorbed on the clay particles by cationic exchange. Owing to the selective absorption properties of many plants, radioisotopes may become concd. in edible plants; this situation provides the hazard. The idea of growing plants and subsequently discarding them elsewhere is noted as a possibly practical technique for radiation-decontamination of soil over wide areas." (*Chem. Abs.* 48: 189.)

941. JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE. Research in the effects and influences of the nuclear bomb test explosions. Compiled by the Committee for Compilation of Report on Research in the Effects of Radioactivity. 1824 p. Tokyo, 1956.

942. KIRMAN, B. H. Strontium-90 in man. *Brit. Med. Jour.* 5024: 944. 1957.

A commentary to a previous article published in the *Brit. Med. Jour.* 5021, p. 752, under the same title in regard to the possible genetic hazard of Sr^{90} .

943. KULP, J. L., ECKELMANN, W. R., and SCHULERT, A. Strontium-90 in man. *Science* 125: 219-225. 1957.

To determine the amount of radioactive strontium in human bones today, three scientists from Columbia University analyzed about 500 autopsy samples obtained from 17 stations in a worldwide network. They concluded that if bomb tests continue at their present rate, the average worldwide concentration in 1970 will be 4 to 8 micro-microcuries of strontium-90 per gram of calcium. The higher figure approaches the significant level established by the British Medical Council in its June 1956 report.

944. LANGHAM, W., and ANDERSON, E. C. Strontium-90 and skeletal formation. *Science* 126: 205-206. 1957.

"It is assumed that each yearly increment of skeletal growth will contain Sr^{90} at a concn. corresponding to the Sr^{90} build-up in the biosphere for that year. The apparent equilibrium Sr^{90}/Ca ratio as a function of age, based on skeletal growth rate alone and a yearly doubling time of the Sr^{90} level, was calcd. The values for 1-24 years, resp., were: 0.79; 0.59; 0.42; 0.29; 0.20; 0.16; 0.16; 0.18; 0.20; 0.22; 0.23; 0.24; 0.23; 0.22; 0.21; 0.19; 0.16; 0.13; 0.09; 0.045; 0.019; 0.006; 0.001; 0.000. If the fraction of remodeling and exchange for children's bone is similar to that for adults (10% of the skeletal Ca), then the above accretion curve below age 20 should be raised proportionately. This curve indicates an av. max. equil. level of 0.9 micromicrocurie/g. of Ca at the end of 1955. Since the Sr^{90} environmental contamination level continued to rise during 1956, the predicted av. max. Sr^{90} equil. level of new bone as of the first part of 1957 is about 1.8 micromicrocurie/g. of Ca." (*Chem. Abs.* 51: 16780.)

945. LAPP, R. E., and others. Strontium-90 in man. *Science* 125: 933-934. 1957.

J. L. Kulp, W. R. Eckelmann, and A. Schulert, joint authors.

Discussion of the interpretation of experimental data on the retention of strontium 90 from fission fallout in man.

946. LEWIS, E. B. Leukemia and ionizing radiation. *Science* 125: 965-972. 1957.

Review with 57 references.

947. LIBBY, W. F. Radioactive strontium fallout. *Natl. Acad. Sci. Proc.* 42: 365-390. 1956.

"A short discussion was given earlier (cf. C.A. 50, 10552h). Detailed discussions and results of exptl. measurements of Sr^{90} are given in tables for pre-Castle and post-Castle (fallout), for domestic and foreign soils, rivers, and lakes. The transfer of Sr^{90} from soil to plant, from plant to animal, from animal (milk) to human, is discussed. The efficiency of collecting fallout with the gummed paper method is surveyed." (*Chem. Abs.* 50: 14374.)

948. LIBBY, W. F. Radioactive fallout. *Natl. Acad. Sci. Proc.* 43: 758-775. 1957.

"The radioactivity produced by the fission reaction changes its characteristics continuously and rapidly following the explosion of an atomic weapon, and the conditions of firing are of extreme importance in determining the rate at which the radioactivity descends to earth. Hazard from local fall-out, tropospheric fall-out, and stratospheric fall-out are evaluated. Hazards to man from the uptake of environmental radiocesium and radiostrontium are considered in detail. Data are presented from surveys on variations in individual Sr^{90} burdens, variations of the Sr^{90} body burden with locality, and the estimated effects of continued nuclear weapons testing on the body burden of Sr^{90} . Project Sunshine, established to study the problems of world-wide fall-out, is discussed briefly." (*Nuclear Sci. Abs.* 11: 11884.)

949. LOUTIT, J. F. Strontium-90 in man. *Brit. Med. Jour.* 5024: 943-944. 1957.

A brief review of the factors and information that are considered in assessing the hazard of Sr^{90} to man. Also a commentary on a lead article appearing in the *Brit. Med. Jour.* 5021, p. 752, under the same title.

950. NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL. The effects of atomic radiation on oceanography and fisheries. Report of the Committee on Effects of Atomic Radiation on Oceanography and Fisheries. NAS-NRC Pub. 551, 146 p. Washington, D.C., 1957.

951. NEWCOMBE, H. B. Magnitude of biological hazard from strontium-90. *Science* 126: 549-551. 1957.

952. OPHEL, I. L. Fallout and the strontium-90 hazard. *Science* 125: 399. 1957.

953. RAND CORPORATION, SANTA MONICA, CALIF. Worldwide effects of atomic weapons project Sunshine. U.S. Atomic Energy Comn. AECU-3488, 96 p. 1953.

"In this preliminary report are discussed the various aspects of long-range contamination due to the detonation of large numbers of nuclear devices. An improved methodology for assessing the human hazard is developed, and an extensive experimental program is proposed." (Author's summary.)

954. RUSSELL, R. S., MARTIN, R. P., and WORTLEY, G. An assessment of hazards resulting from the ingestion of fall-out by grazing animals. Atomic Energy Res. Estab. (Gt. Brit.) ARC/RBC-5, 25 p. 1956.

"The present calculations suggest that if fission products are deposited in a freely soluble form, the limiting hazard in the initial period will be due to the metabolic accumulation of I^{131} and Sr^{90} . The maximum permissible levels of deposition from the viewpoint of infants consuming milk are similar to those for the grazing animals themselves. Pastures contaminated with *freely soluble fission products* in excess of 0.4 mc./m² at 1 day should be regarded as potentially hazardous. The consumers of butter and cheese would however be subject to no hazard unless considerably higher depositions occurred. Milk would be safe for feeding to young farm stock when contaminated above the M.P.L. for infants. The M.P.L. from the viewpoint of injury to the gastrointestinal tract of free grazing animals would be attained when the deposition

exceeded 10 times that which would give rise to hazard through metabolic accumulation. The minimum deposition of fission products that could be hazardous through ingestion would cause the external exposure from T-radiation to be less than 0.2 r./hour at 1 hour; the total dose from 1 hour would be less than 1 r. However, the circumstances of an emergency could cause a marked variation in the relative magnitude of hazards from internal and external sources." (Excerpt from author's abstract.)

955. SPIERS, F. W. Radioactivity in man and his environment. *Brit. Jour. Radiol.* 29: 409-417. 1956.

"Presidential address before British Institute of Radiology, summarizing all published data." (*Chem. Abs.* 50: 16889.)

TOXICOLOGICAL ASPECTS OF RADIOSTRONTIUM

ACUTE AND CHRONIC TOXICITY

958. ABRAMS, R., and others. Metabolism of inhaled fission product aerosols. *U.S. Atomic Energy Comm. MDDC-248*, 114 p. 1946.

H. C. Seibert, A. M. Potts, W. Lohr, and S. Postel, joint authors.

Contents cover the metabolism in rats of the following airborne fission products: 55^dSr^{90} , 65^dZr^{95} , 57^dY^{91} , and 275^dCe^{144} ; physical and biological properties, experimental procedure, and metabolism are discussed for each isotope; preparation of isotopes used are covered briefly; references; figures and radioautographs.

959. AKADEMIIA MEDITSINSKIKH NAUK S.S.S.R., INSTITUTE OF SANITATION AND OCCUPATIONAL DISEASE. Data on toxicology of radioactive materials. I. Cesium, strontium, ruthenium, and radon. Moscow, 1957.

Articles are presented on absorption, distribution, and excretion of radioactive materials of Sr, Cs, Ru, and Rn. The radiotoxic effects of Ru, Ce, Sr, and Rn under acute and chronic conditions are analyzed. Experiments in stimulating the excretion of Sr and Ce from the organism are discussed.

960. ANDERSON, W. A. D., ZANDER, G. E., and KUZMA, J. F. Toxic doses of strontium-90 in the adult rat. *Amer. Med. Assoc. Arch. Path.* 62: 433-440. 1956.

" Sr^{90} injected into rats is considerably more toxic than Sr^{90} . Like the latter, it accumulates in the bones and inhibits hematopoiesis and eventually causes osteogenic sarcoma." (*Chem. Abs.* 51: 3818.)

961. ANTHONY, D., LATHROP, K., and FINKLE, R. Radiotoxicity of injected Sr^{90} for rats, mice, and rabbits. Pt. I. Introduction; Methods. *U.S. Atomic Energy Comm. MDDC-1540*, 15 p. 1946.

Toxic effects and metabolism of radiostrontium (Sr^{90} - Sr^{90}) were studied. Determinations were made of the acute lethal doses for rats, mice, and rabbits and of comparative toxicity and metabolism after intraperitoneal and intravenous administration. Distribution of radiostrontium in various organs was made. A method is described for handling and preparing radioactive Sr for experimental animals.

962. ANTHONY, D., LATHROP, K., and SNYDER, R. Radiotoxicity of injected Sr^{90} for rats, mice, and rabbits. Part III. Lethal action and clinical changes. *U.S. Atomic Energy Comm. MDDC-1364*, 14 p. 1947.

"The LD_{50} in 30 days was found to be between 7 and 8 $\mu\text{c./g.}$ of Sr^{90} - Sr^{90} when administered intraperitoneally to mice. For rats and for rabbits it was slightly less than 5 $\mu\text{c./g.}$ The food intake and gain in weight of rats and mice given doses of 2 $\mu\text{c./g.}$ or more, with no apparent symptoms of radiation sickness, were less than those of the control animals." (Author's abstract.)

956. U.S. ATOMIC ENERGY COMMISSION. The nature of radioactive fallout and its effects on man. Hearings before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Congress of the United States, 85th Congress, 1st session, on the nature of radioactive fallout and its effects on man. Pt. 1, p. 1-1008. 1957.

957. U.S. ATOMIC ENERGY COMMISSION. The nature of radioactive fallout and its effects on man. Hearings before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Congress of the United States, 85th Congress, 1st session, on the nature of radioactive fallout and its effects on man. Pt. 2, p. 1009-2065. 1957.

963. ARGONNE NATIONAL LABORATORY, BIOLOGICAL AND MEDICAL RESEARCH DIVISION. Quarterly report. *U.S. Atomic Energy Comm. ANL-5247*, 81 p. 1954.

964. AUB, J. C., and others. Studies of calcium and phosphorus metabolism. XXIII. Effects of treatment on radium and calcium metabolism in the human body. *Ann. Int. Med.* 11: 1443-1463. 1938.

R. D. Evans, D. M. Gallagher, and D. M. Tibbetts, joint authors.

965. BLOOM, W. Histological changes following radiation exposures. *Radiology* 49: 344-348. 1947.

"Effects were independent of a wide variety of types of radiation except for β -rays. No evidence was found for a stimulating effect of low doses of X-rays. Mitosis or meiosis is not a pre-disposing factor detg. radiosensitivity." (*Chem. Abs.* 42: 232.)

966. BREITLING, G. Radiation protection in the use of β -emitters. *Fortschr. auf dem Geb. der Röntgenstrahlen u. der Nuklearmed.* 85: 453-456. 1956.

967. BRUES, A. M., ed. Experimental pathology, special problems, invertebrate zoology, microbiology, phytobiology, physiological chemistry, organic chemistry, organic chemistry, physical chemistry, pharmacology, theoretical biology, and biophysics. *U.S. Atomic Energy Comm. ANL-4840*, p. 57-108. 1952.

Progress is reported on the following studies: The toxicity of Sr^{90} in mice; the fate and pathologic effects of Pu metal implanted in rabbits and rats; blood-pressure changes in X-irradiated chicks; the effect of high-energy neutrons on metabolism in the egg nuclei of grasshopper nymphs; antibiotic and radiation sensitivity of auxin biosynthesis; the use of ethylenediamine as a carbonate-free alkali for CO_2 adsorption; the mechanisms involved in the reversal of toxicity of Be, B, and U; the investigation of hormonal factors governing the response of rat liver triptophan peroxidase-oxidase to total-body X-irradiation; a statistical estimation of the concentration of microorganisms using the dilution method; studies of the kinetics of population growth of microorganisms; the determination of photographic film exposure by neutron activation of Ag^{107} ; a mathematical analysis of the growth of bacterial colonies; incorporation of Gd into liquid scintillators for increasing sensitivity to thermal neutrons; the possibilities and limitations of fluorescent X-ray analysis by means of proportional counters; and a study of the mechanisms operating in the ionization-type halide detector.

968. BRUES, A. M., LISCO, H., and FINKEL, M. P. Biological hazards and toxicity of radioactive isotopes. *Jour. Clin. Invest.* 28: 1286-1296. 1949.

Permissible exposure levels are determined by late or chronic radiation changes. Sections are included on units and dosage calculations, nature of isotope toxicity, tolerance or permissible dose, justification for dosage exceeding

the permissible, toxicity of bone-seeking elements, and review of studies of bone-tumor induction by Sr^{90} in mice.

969. BUCHANAN, D. L., GASVODA, B., and BAR-
RON, E. S. G. Biochemistry; effects of a single lethal
intravenous dose of radioactive strontium chloride on the
plasma proteins of a goat. U.S. Atomic Energy Comm.
MDDC-1418, p. 130-135. 1947.

Study of the electrophoretic patterns of the plasma of
a goat before and after the intravenous injection of a
lethal dose of radioactive strontium; changes seen are a
moderate decrease in albumin and two globulins.

970. BURSTONE, M. S. A histochemical study of ir-
radiated bone. Amer. Jour. Path. 28: 1133-1141. 1952.

"Radioactive P administered systemically or locally (ad-
jacent to bone) results in a destruction of the normal bone
marrow and subsequent replacement by abnormal reticular
cells. These cells contain greater than normal amts. of
glycoprotein, glycogen, and alk. phosphatase, and are
assocd. with a glycoprotein-containing matrix which is
calcified." (Chem. Abs. 47: 4505.)

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Amer. Dent. Assoc. Jour. 47: 630-636. 1953.

A summary of the use of radioisotopes in experimental
studies of cellular injury. 26 references.

972. BURYKINA, L. N. Changes in the peripheral
blood in acute reaction to ruthenium, strontium, and
cesium by the organism. Mater. Toksikol. Radioaktiv.
Veshch. (Moscow: Gosud. Izdatel. Med. Lit.) Sborn.
1: 61-76. 1957.

"A comparative evaluation of the radioactivity of the
same doses of Ru^{106} , Sr^{90} , Cs^{134} on rats showed that Ru^{106}
came first. Unlike Sr^{90} and especially Cs^{134} , Ru^{106} caused
an acute leucopenia, temporary neutropenia and throm-
bopenia, and a well-defined anemia; the latter developed
one month after the treatment with the Ru^{106} ." (Chem.
Abs. 52: 3151.)

973. COCHRAN, K. W., and others. Studies on zirc-
onium, tantalum, columbium, strontium and lanthanum.
I. Acute toxicity and effects on enzymatic reactions.
Chicago Univ. Toxicity Lab. Quart. Prog. Rpt. 1 on
Radiobiol., p. 11-21. 1949.

M. Mazur, J. Doull, and K. P. DuBois, joint authors.
"Cesium chloride failed to inhibit the ATP-ase activity
of mouse liver in vitro, while salts of other metals caused
50 percent inhibition at the following molar concentra-
tions: Columbium chloride, 4.2×10^{-4} ; potassium colum-
bate, 5.8×10^{-4} ; lanthanum chloride, 4.4×10^{-3} ;
strontium chloride, 8.3×10^{-2} ; yttrium chloride, $4.5 \times$
 10^{-3} ; and zirconium chloride, 1.05×10^{-3} ." (Excerpt
from author's summary.)

974. COHEN, W. E. Toxicity of inhaled or ingested
radioactive products. Nucleonics 3 (1): 21-26. 1948.

Gives formulation for estimating roentgens received per
day from ingested or inhaled dose.

975. COHN, S. H., and others. Radiotoxicity resulting
from exposure to fallout simulant. II. The metabolism
of an inhaled and ingested simulant of fallout produced by
a land-based nuclear detonation. U.S. Nav. Radiol. De-
fense Lab., San Francisco, Calif., USNRDL-TR-118, 24
p. 1957.

W. B. Lane, J. K. Gong, R. K. Fuller, and W. L. Milne,
joint authors.

Study reproduced in the laboratory an acute exposure
of mice to early fallout (2 days old), such as might result
from a land-based nuclear detonation.

976. COWAN, F. P., FARABEE, L. B., and LOVE,
R. A. Health physics and medical aspects of a strontium⁹⁰
inhalation incident. Amer. Jour. Roentgenol., Radium
Ther., and Nuclear Med. 67: 805-809. 1952.

"The urinary elimination of Sr^{90} -Y⁹⁰ after inhalation by
a human subject has been studied. The rate of elimina-

tion per day dropped from 20,300 disintegrations/min. on
the 1st day to 130 disintegrations/min. on the 27th day.
Elimination persisted with an effective half life of 23 days
for a period of about 3 months after the initial rapid
elimination was over. Elimination leveled off at 16 disin-
tegrations/min./day, indicating a very small deposition in
the bones." (Chem. Abs. 46: 7131.)

977. CRONKITE, E. P., BOND, V. P., and DUN-
HAM, C. L., eds. Some effects of ionizing radiation on
human beings, report on Marshalllese and Americans acci-
dentally exposed to radiation from fallout and a discussion
of radiation injury in human beings. U.S. Atomic Energy
Comm. TID-5358, 106 p. 1956.

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A. H. Toxicity of radiostrontium in monkeys. Nature
172: 122-123. 1953.

"A preliminary report which indicates that Sr^{90} is more
toxic to monkeys (species undesignated) than to other
animals. Two microcuries/kg. gave a survival time of
about 14 days while 0.5 microcuries/kg. gave survival times
of from 35 to 56 days. All the animals apparently died
from anemia." (Chem. Abs. 47: 12622.)

979. EDINGTON, G. M., JUDD, J. M., and WARD,
A. H. Delayed toxicity of radiostrontium in monkeys.
Nature 175: 33. 1955.

"Six monkeys died following single injections of Sr^{90} of
less than 0.2 mc./kg. body-weight. Data are presented on
hematological findings and survival-times and are com-
pared with those in animals which received higher doses."
(Nuclear Sci. Abs. 9: 2114.)

980. EDINGTON, G. M., and others. The acute lethal
effects in monkeys of radiostrontium. Jour. Path. and
Bact. 71: 277-293. 1956.

A. H. Ward, J. M. Judd, and R. H. Mole, joint authors.
"Monkeys of the genus *Cercopithecus* killed acutely by
a single intramuscular injection of Sr^{90} show the findings
of a rapidly progressive anemia, lymphopenia, and hemo-
siderosis of liver and spleen. The damage to the bone
marrow was by irradiation from the radioactive material
in the bone. The L.D.₅₀ < 30 days was 0.7 mc./kg. After
doses somewhat less than this, there seemed to be some
recovery in spite of continued irradiation. Monkeys
retained a larger fraction of radio-Sr than any other
species examd. and of this 96% was in the skeleton. Fecal
excretion was slightly greater than urinary. 25 refer-
ences." (Chem. Abs. 10: 15937.)

981. FINKEL, M. P. Experimental pathology—The
retention of radiostrontium by *Rana pipiens*. U.S. Atomic
Energy Comm. ANL-4147, p. 85-88. 1948.

Contains preliminary experiments on retention, distri-
bution, and acute and latent effects of radiostrontium in
frogs.

982. FINKEL, M. P. Relative biological effectiveness
of internal emitters. Radiology 67: 665-672. 1956.

"The acute toxicity and chronic toxicity of internally
deposited radioisotopes are being studied in CF1 female
mice under standardized conditions. All the alpha-emit-
ting isotopes that have been tested are approximately 20
times as effective as Ra^{226} (on the basis of dose injected
per unit weight) in killing half of the population in 20 to
30 days. This result is not readily explainable in terms
of particle energy, physical half life, biological half time,
or tissue distribution, but these factors may be operating
nonetheless. The beta-emitting isotopes that have been
tested are less potent killing agents at acutely lethal levels
than Ra^{226} . Their relative effectiveness can be interpreted
in large part on the basis of energy and half life; those
with relatively long half lives are approximately twice as
lethal as those with very short half lives, and there appears
to be a direct relationship between energy and lethality.
Tissue distribution and retention seem to be relatively
unimportant when acute lethality is the criterion of effect.
Comparisons of net average mortality rates from the time

of injection to 425 days later show increasing values of relative biological effectiveness with increasing mortality rate. At the lowest measured rate the ratios were $15(\text{Pu}^{239}):4(\text{Po}^{210}):1(\text{Ra}^{226}):0.07(\text{Sr}^{90}):0.02(\text{Sr}^{89})$. During the first 425 days there was a perceptible increase in mortality rate, with lymphoid tumors among the animals that received appropriate doses of Pu^{239} , Ra^{226} , Sr^{89} , Sr^{90} , and Ca^{45} and a pronounced increase among those that received Po^{210} , P^{32} , and Y^{90} . Tentative figures for relative effectiveness in inducing malignant bone tumors based on an average rate of 10 deaths with bone tumors per 25 days per 100 animals are $20(\text{Pu}^{239}):1(\text{Ra}^{226}):0.2(\text{Sr}^{90}):0.1(\text{Sr}^{89}):0.05(\text{Ca}^{45})$. (Author's summary.)

983. FINKEL, M. P., BRUES, A. M., and LISCO, H. The toxicity of Sr^{89} in mice. U.S. Atomic Energy Comm. ANL-5247, p. 25-29. 1954.

"The biological effectiveness of a single dose of Sr^{89} was compared with repeated doses. The data indicated that repeated doses are about half as effective as the total dose given at one time. This may be due to recovery or may be the effect of a latent period making doses close to the time of death relatively noncontributory to mortality." (Excerpt from author's summary.)

984. FINKEL, M. P., and others. The influence of dosage pattern upon the toxicity of Sr^{90} in mice. I. Preliminary experiment and 212-day survey of the long-term study. U.S. Atomic Energy Comm. ANL-5732, p. 21-31. 1957.

B. J. Telleson, J. Lestina, and B. O. Biskis, joint authors.

985. FRIEDEL, H. L., and SALERNO, P. R. The potentiated lethal action of radioisotopes used in combination. Internatl. Conf. Peaceful Uses Atomic Energy Proc., Geneva, (1955) 11: 165-168. 1956.

986. FRIEDEL, H. L., SALERNO, P. R., and ROSENBERG, S. A. The mechanism of potentiated lethal action of certain radioisotopes in rats and mice. U.S. Atomic Energy Comm. NYO-4020, 22 p. 1953.

"A potentiated lethal action was observed in rats and mice when a bone-localizing internal emitter such as P^{32} or Sr^{89} was administered in combination with colloidal Au^{198} . It was noted that the toxicity of colloidal Au^{198} in rats and mice was not altered by splenectomy. However, the lethal action of the bone-seeking radioactive isotopes was found to be clearly more effective in splenectomized animals. This sensitizing action of splenectomy was found to be of the same order of magnitude as the degree of potentiation observed when P^{32} was combined with colloidal Au^{198} . Furthermore, the intensity of the combined lethal action of these two isotopes was found to be the same in both normal and splenectomized animals. Since the acute effects of relatively small doses of colloidal Au^{198} are equivalent to splenectomy, the level of sensitivity of animals that receive Au^{198} in combination with P^{32} or Sr^{89} is reduced to that of splenectomized animals. Splenectomy did not greatly modify the sensitivity of either rats or mice to X-rays. Apparently the total body dose in the lethal range severely injures the spleen. Since the bone marrow can partially recover independently, the injured spleen without its special protective function is not a major determinant in survival. It was noted that more than four times as much Sr^{89} could be tolerated by mice with intact spleens as by splenectomized mice. As would be anticipated, it was found that when colloidal Au^{198} was given in combination with Sr^{89} , the potentiation of the lethal effect was also increased approximately fourfold. This potentiation is much more striking in the mouse than in the rat, and these data suggest that the mouse may be unique with respect to the potentiality of the spleen in influencing survival after radiation injury to the bone marrow." (Author's summary.)

987. GROSCH, D. S., SULLIVAN, R. L., and LACHANCE, L. E. Comparative effectiveness of four beta-emitting isotopes fed to *Habrobracon* females on pro-

duction and hatchability of eggs. Radiation Res. 5: 281-289. 1956.

988. JACOBSON, L. O., SIMMONS, E. L., and BLOCK, M. H. Effect of splenectomy on the toxicity of strontium⁸⁹ to the hematopoietic system of mice. Jour. Lab. and Clin. Med. 34: 1640-1655. 1949.

"Persistent leucopenia but no significant anemia is seen in mice injected intraperitoneally with 2 microcuries of $\text{Sr}^{89}\text{Cl}_2$ per g. The same dose produces both leucopenia and anemia in splenectomized mice, but recovery from the anemia is complete in 119 days. Hematopoiesis is greatly reduced in the bone marrow of all Sr^{89} -treated animals within 3 days, but recovery is essentially complete in 119 days. Ectopic erythrocytopoiesis and megakaryocytopoiesis is greatly increased in the spleen, but lymphocytopoiesis is reduced in this organ, though not in other lymphatic tissues. Granulocytopoiesis increases much more slowly in the spleen (max. in 60 days). None of these processes is noteworthy in other tissues of Sr^{89} -treated mice." (Chem. Abs. 44: 6027.)

989. KAPITSA, L. M., and FEDOROVA, A. D. Effect of radioactive isotopes of strontium on bone fracture consolidation. Vest. Rentgenol. i Radiol. 31: 18-21. 1956.

"Intravenous administration of radiostrontium results in its uptake in the bones predominantly at the site of newly forming bone; the result is the stimulation of regeneration of bone tissue and accelerated consolidation of the fracture. Min. doses were used (1.6 microcuries/kg.)." (Chem. Abs. 50: 14947.)

990. KEPP, R. K., and OEHLERT, G. Studies on the biological dose equality of hard X-rays of 180 kv and radiostrontium electrons in monocellular ova of *Ascaris megalocephala*. Strahlentherapie 103 (2): 392-397. 1957.

991. KORTKOV, F. G., LEBEDINSKY, A. V., and IGNATYEV, A. I., eds. Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation. Report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R. 74 p. Moscow, State Medical Literature Press, 1956.

992. KUZMA, J. F., and ZANDER, G. E. Pathologic effects of calcium-45 and strontium-89 on bone and soft tissues. Marquette University School of Medicine progress report for period ending March 15, 1954. 7 p. Milwaukee, Wis., 1954.

993. KUZMA, J. F., and ZANDER, G. E. Pathologic effects of calcium-45 and strontium-89 on bone and soft tissues. Marquette University School of Medicine progress report for period ending March 15, 1955. 19 p. Milwaukee, Wis., 1955.

994. LITVINOV, N. N. Morphologic changes in the bone tissue of rats in acute radioactive strontium intoxication. Arkhiv Patol. 18: 81-88. 1956.

"Expts. were performed with 57 white male rats 3 months old. Each rat received intraperitoneally an injection of H_2O soln. of Sr^{90} in doses of 1.6 $\mu\text{c./g.}$ of body wt. Daily, for a period of 25 days, after the Sr^{90} injection, 1 or 2 rats were sacrificed until 42 rats were thus disposed of. The remaining rats died variously 39, 57, 77, and 108 days after the Sr^{90} injection, except for 2 rats which survived such periods and had to be sacrificed for study. Controls were also tested. In the rats which received the Sr^{90} as per above, there were observed within 2-3 days a widening of the endostium with an accompanying development of fibrocellular tissue contg. many osteoclasts, and an increased absorption of bone substance. In the zone of enchondroitin ossification there occurred a delay in the absorption of the cartilage, and in the formation of new bone tissue a disturbance was observed, while the number of osteoblasts appeared to be reduced. Within the period of 4-12 days changes were observed which indicated that

a progressive depression in the activity of the bone tissue was becoming manifest. The osteogenic fibro-cellular tissue was gradually replaced by a heavily fibrous connective tissue which filled the recesses of the metaphysis and spread over the endosteal side of the diaphysis. The remaining osteostructures acquired an irregular formation as a result of the absorption of the bone and of the newly formed immature bone substance. Absorption of the cartilage of the epiphyseal plate and the process of formation of new bone structure were at first disturbed and subsequently arrested. Within 13-25 days the effects of Sr^{90} reached their height. Here were observed changes which reflect a profound depression of the process of the life of the bone tissue. The bone rebuilding and new bone formation processes had been completely arrested in the zones of usual growth. The structure of cortical layer of the metaphysis and of the diaphysis were disturbed. Within 31-108 days, in the rats which survived the above-described period and which either subsequently died or had to be sacrificed, there were observed in the bone tissue manifestations of abnormal processes of regeneration. In the metaphysis there occurred the formation of atypical and variously immature bone tissue, evidencing that the processes of bone substance formation were profoundly disturbed." (Chem. Abs. 50: 14975.)

995. LITVINOV, N. N. Morphologic changes in the bone tissue of rats during chronic intoxication by radioactive strontium. *Arkiv Patol.* 19: 26-31. 1957.

"White male rats (186) of 3 months of age were used in the expts. Each rat was injected intraperitoneally with Sr^{90} at the rate of 0.4 microcurie/g. of animal wt. Rats were killed at 1-450 days after the Sr injection. Of the rats injected 27 died 100 days or later after the expt. began.

The tibia, the femur, and in some instances the humerus were decalcified in 10% HNO_3 . Marked changes in the bone structure were observed. Such changes have a definite sequence of development and are most in evidence in the metaphyses of the long tubular bones. The changes are described which occur in the bone structures from 2 months on." (Chem. Abs. 51: 6002.)

996. MANOILOV, S. E., GRAEVSKAIA, B. M., and SHIMANOVSKAIA, K. B. Chronic action of radium salts on the animal organism. *Vest. Rentgenol. i Radiol.* 6: 43-49. 1955.

Injection into rats of 0.02-200 μc . of Ra caused a mortality of 31-100 percent. Parenteral injection of 1,750 μc . P^{32} also caused 100 percent mortality. A dose of 0.002 μc . Ra and 1,500 μc . P^{32} was not lethal to the animals, but they showed symptoms of irradiation disease. Injection of 0.002-0.02 μc . Ra leads to a rise, but injection of 380-2,200 μc . P^{32} leads to a fall, of liver glycogen. The cathepsin activity of the liver was diminished in the first days after injection of 0.02 μc . Ra, but on the 44th day it was raised by 50 percent. On injection of a small dose of P^{32} the activity of liver cathepsins was unchanged on the second day, but after a lethal dose (1,750 μc .) it was lowered. [Russian.]

997. MARINELLI, L. D., QUIMBY, E. H., and HINE, G. J. Dosage determination with radioactive isotopes. *Nucleonics* 2: 56-66. 1948.

"When radioactive isotopes are employed either as tracers or in therapy, it is important to be able to det. the radiation dosage. This cannot, in general, be measured, but when the half-life, radiation energy, and biol. uptake and excretion are known, it can be calcd. This paper is divided into two parts, based on phys. and clinical aspects of the problem. In the phys. part (Part I) are given math. developments of formulas for dosage rates and total doses for β - and γ -ray-emitting isotopes, together with subsidiary formulas for safe concn. In the clinical part (Part II) these formulas are applied for dosage considerations for specific cases, with isotopes of common interest. Particular consideration is given to the detn. of safe tracer doses. Two extensive tables are presented, for β - and γ -rays, resp., giving half-life, av. radiation energy, fraction disintegrating per day, and specific dosage data,

including the safe tracer concn., for some 38 isotopes." (Chem. Abs. 42: 7812.)

998. MASSACHUSETTS INSTITUTE OF TECHNOLOGY, RADIOACTIVITY CENTER. Radium and mesothorium poisoning and dosimetry and instrumentation techniques in applied radioactivity. Annual progress report. U.S. Atomic Energy Comm. AECU-3261, 97 p. 1956.

"Includes studies on bone grafts using Ca^{45} , the distribution of Ca^{45} in bone, the three dimensional localization of hot spots in bone, the removal of radiocalcium from dogs, and the comparative uptake and retention of radioactive calcium and strontium in the skeleton of adult rats." (Nuclear Sci. Abs. 11: 5179.)

999. MEDNIKYAN, G. A., and VINIKOVA, B. G. Pharmacology of SrCl_2 . *Farmakol. i Toksikol.* 17: 43-46. 1954.

"In mice the M.L.D. of SrCl_2 is 1.5 g./kg.; L.D.₅₀ is 1.75 g./kg. (subcutaneous injections). It intensifies adrenaline secretion, acts as a local anesthetic, raises smooth muscle tonus, acts as a vasodilator (isolated rabbit ear), and has a depressor effect (cats). At 1:1000 and 1:600 it has pos. inotropic and chronotropic effects; at 1:200 and 1:100 these effects are neg." (Chem. Abs. 48: 13986.)

1000. MILLER, B. L., and HOECKER, F. E. Quantitation of alpha emitters in bone. *Nucleonics* 8: 44-52. 1951.

"To measure the very small amts. of radium in sections of bone, it is necessary to know the relative activities of Ra/Rn. Instrumental alpha counting is not feasible, so that autoradiographic technics were adapted to give at least a valid first approximation. The alpha tracts from Ra, Rn, Ra A, Ra C', and Ra F were recorded on an NTA plate and again with the softer alpha particles from Ra filtered out by aluminum. These remaining tracks, corrected for absorption, were due to Rn, Ra, and Ra C', of which $\frac{1}{4}$ were due to Rn since the time of exposure was not long enough to give appreciable amts. of Ra F. A theoretical basis for the procedure and calculation was developed." (Biol. Abs. 26: 14418.)

1001. MILNE, W. L., and COHN, S. H. Effects of combined exposure to strontium-90 and external radiation. *Fed. Proc.* 15: 524. 1956.

The effects of both strontium-90 and external total body X-irradiation administered separately and in combination were determined in terms of platelet-level changes, body weight, and mortality. Platelet level was found to be the most sensitive and reproducible index of radiation injury. The effects produced by radiation from internally deposited Sr^{90} differed from those resulting from total body external X-radiation, in that both the onset of radiation damage and the recovery were more gradual. The depression of platelet level was proportional to the dose of Sr^{90} up to the L.D. 40/30-day dose, or approximately 5 μc /g. body weight. The depression of platelet level following a sublethal dose of total body X-irradiation (625 roentgens) was enhanced in animals previously injected with Sr^{90} at levels of 0.1 μc /g. or higher. The threshold dose of Sr^{90} injected intraperitoneally required to produce platelet depression was 0.1 μc /g. body weight. The acute depression of platelet level produced by the simultaneous administration of a sublethal dose of external radiation and low level of Sr^{90} was also studied.

1002. MITLIN, N., and BABERS, F. H. Action of radiostrontium in the housefly and German cockroach. *Jour. Econ. Ent.* 49: 714-715. 1956.

"Continuous feeding of $\text{Sr}^{90}\text{Cl}_2$ to flies caused complete sterility, but 18 hrs. feeding resulted in only partial decrease in egg viability. Results on cockroach were less conclusive." (Chem. Abs. 51: 4583.)

1003. NELSON, J., and others. Effect of radioactive strontium on the peripheral blood picture in the normal

dog. *Acta Unio Internatl. Contra Cancrum* 6: 819-824. 1949.

J. G. Gibson, B. L. Vallee, and M. A. Van Dilla, joint authors.

1004. OLIVER, R., and VAUGHAN, J. An attempt to assess the dosage of strontium-90 received by young rabbit bone. *Brit. Jour. Radiol.* 29: 668-672. 1956.

"In young rabbits radioactive strontium is concentrated in areas of active bone growth. The radiation dose is closely related to percentage retention per gram of bone. Calculation of radiation dose based on such observed retention shows that the dose actually received in certain areas may be appreciably greater than if a uniform distribution of the isotope were assumed. These calculations only establish the principle that an uneven distribution in bone must be assumed in calculations of radiation hazards. The absolute results in any species would vary according to age, size and species retention pattern." (*Nuclear Sci. Abs.* 11: 2983.)

1005. OWEN, M., SISSONS, H. A., and VAUGHAN, J. The effect of a single injection of high dose Sr^{90} (500-1000 $\mu\text{c./kg.}$) in rabbits. *Brit. Jour. Cancer* 11 (2): 229-248. 1957.

"Rabbits were injected once with 0.5-1.0 mc./kg. of Sr^{90} as $\text{Sr}^{90}\text{Cl}_2$. Rabbits injected at the age of 2 days and killed 6-18 months later showed no abnormality of hemopoiesis or of the skeleton. Some of the rabbits injected at the age of 6-8 months died with acute anemia and leucopenia; those surviving for 6 months developed multiple osteosarcomas. Rabbits 1 year old at the time of injection survived 6 months or longer. Some developed anemia and leucopenia and some single bone tumors were found. In both older groups there were loss of wt., atrophy of the gonads and spleen, and gelatinous degeneration of bone marrow and fatty tissue. Bone damage was most extensive in the 6-8 week group with abnormal bone formation, damage to blood vessels and patchy necrosis. Tumors developed in relation to the sites of max. retention of Sr^{90} ." (*Chem. Abs.* 52: 5511.)

1006. PROKHONCHUKOV, A. A. Changes in the hard tooth tissues after multiple exposures to small doses of ionizing radiation. *Med. Radiol.* 2: 74-77. 1957.

The hard tissues of rats' teeth exposed 25 to 36 times to small doses of X-radiation (25 roentgens) were studied with the aid of radioactive isotopes of P^{32} and Ca^{45} . It was revealed that the changes in phosphorus-calcium metabolism depend on the total doses of irradiation. After a total dose of 700 roentgens the phosphorus-calcium metabolism is activated in the hard tissues of teeth and with 900 roentgens it becomes pronounced.

1007. PROSSER, C. L., and others. Clinical sequence of physiological effects of ionizing radiation in animals. *Radiology* 49: 299-313. 1947.

E. E. Painter, H. Lisco, A. M. Brues, L. O. Jacobson, and M. N. Swift, joint authors.

"On the basis of extensive expts. it is concluded that every kind of ionizing radiation is similar in its clinical action. Nearly every organ system is affected by lethal doses of every type of radiation, and no single clinical reaction is peculiarly specific for irradiation damage. The clinical picture and the conditions resulting in death vary with the dose rate and the duration of exposure for both external and internal radiation. If an animal survives one depression it is likely to die later from a different mechanism." (*Chem. Abs.* 42: 232.)

1008. RAY, R. D. Experimental studies on bone and strontium metabolism. U.S. Atomic Energy Comm. ANL-5584: 69-82. 1956.

"The M.L.D._{50/50} days for Sr^{90} in young growing rats is approx. 2.5 $\mu\text{c./g.}$ body wt. At this dose level the general pattern of distribution follows that for trace levels during the first 24-48 hrs., but apparently the serum levels are slightly higher than at trace levels of administration. Over longer periods, extensive histological changes occur in

the skeleton, and these may be correlated with delayed excretion of the isotope. Of various methods for acceleration mobilization of inorg. salts from the skeleton including hormones (parathormone and cortisone), chelating agents, and variations in diet, one of the most effective thus far tested has been a low-P diet. Rats maintained on this diet showed an increased mobilization of Sr^{90} from the skeleton for the first 30 days but little or no increase during the last 30 days. Apparently there is a crit. period during which one can effectively alter skeletal metabolism following administration of bone-seeking radioactive emitters with high levels of activity." (*Chem. Abs.* 51: 4556.)

1009. RAY, R. D., and others. Bone metabolism. II. Toxicity and metabolism of radioactive strontium (Sr^{90}) in rats. *Jour. Bone and Joint Surg.* 38A: 160-174. 1956.

D. M. Thomson, N. K. Wolff, and D. LaViolette, joint authors.

"The M.L.D._{50/50} for Sr^{90} in young Long-Evans rats was estimated to be 2.5 to 3.0 microcuries per gram of body weight. In rats that survived for 50 days, the histological changes in the tibia consisted in disruption of the epiphyseal line, osteosclerosis, aseptic necrosis of the trabecular bone, and depression of the myeloid elements. The metabolism of Sr^{90} after intraperitoneal injection of an M.L.D._{50/50} dose was found similar to that for Sr^{89} , Sr^{90} , and Ca^{45} tracer doses as reported by other authors. Sr^{90} was quickly absorbed from the peritoneal cavity into the blood stream, and at first was distributed in part to the soft tissues. By the end of 1 to 3 hours, however, 75 to 80 percent of the injected dose had been deposited in the skeleton. Up to 15 percent of the injected isotope was excreted in the urine and up to 8 percent in the feces during the first 24 hours; urinary excretion was more variable than the fecal. Mobilization of the isotope from the skeleton was not appreciable during the 5-day experimental period." (Author's summary.)

1010. RUBIN, P., and others. Radiotoxic effects of sulfur-35 in growing cartilage. Consideration of radioactive sulfur (sulfur-35) as a possible radiotherapeutic agent in chondrosarcomas. *Radiology* 69: 711-719. 1957.

C. Brace, H. Gump, R. Swarm, and J. R. Andrews, joint authors.

"The min. dose of S^{35} required to arrest cartilage growth in the weaned rat was found to be 0.1 mc./g. of body wt. The changes were severe, resulting in an irreversible alteration and destruction of the cartilage in the metaphyses and epiphyses. Reversible changes were noted with the lower doses employed." (*Chem. Abs.* 52: 2250.)

1011. SALERNO, P. R., and others. Synergistic lethal action of certain radioisotopes in rats. *Radiology* 58: 564-569. 1952.

H. L. Friedell, J. H. Christie, and M. Berg, joint authors.

"Synergistic lethal action (combined action greater than simple summation) has been clearly established with a number of internally distributed radioactive isotopes. The synergism appears to be a function of the simultaneous radiation injury of two sep. systems. The reticuloendothelial system and the hematopoietic systems are closely related and the effects are much more profound when both are injured than when the injury is confined to either one." (*Chem. Abs.* 47: 2782.)

1012. SCHUBERT, J. Estimating radioelements in exposed individuals. I. Radioelement metabolism. *Nucleonics* 8(2): 13-28. 1951.

"Ion exchange and colloidal absorption are the mechanisms for consideration in interpreting the metabolism of radioelements, particularly bone deposition. Both very large (diameter $\sim 500 \mu\mu$) and small diffusible (diameter $< 1 \mu\mu$) particles leave the blood very rapidly, all other particles leave the blood at rates corresponding to their diameters, i.e., the smaller the diameter, the slower the

rate of disappearance. Colloidal substances, e.g. hydroxides of radioactive cations, are readily taken up by the reticulo-endothelial cells of tissues such as bone marrow, spleen, and the Kupffer cells of the liver. Hence a useful index for anticipation of the metabolic behavior of a cation is the pH at which the hydroxide of a dil. soln. of a simple salt of the element will ppt. Radioelements which are excreted via the kidney represent absorbed fractions, those appearing in the feces represent both absorbed and unabsorbed fractions; therefore, insol. compds. from the lung will not be eliminated in the urine. Sol. substances generally are removed from the lung by passage into the blood stream, insol. substances may be removed mechanically. Treatment of radioelement poisoning with complex-forming agents, e.g. citrate, is discussed." (Chem. Abs. 45: 8059.)

1013. SCHUBERT, J. Estimating radioelements in exposed individuals. II. Radiation dosage and permissible levels. *Nucleonics* 8(3): 66-78. 1951.

"The potential toxicity of a radioelement is a complex function that involves both radioactive or physical factors such as half-life, energy and kind of radiation and physiological and metabolic factors such as administration and rate of elimination, chem. properties and nature of the compd., degree of localization within the body, age and life expectancy of the individual, concn. administered, and the phys. state of the radioelement. A list is given of permissible levels in body and excreta for representative isotopes, which was calcd. by the use of reference standards based on these factors. Man's background radiation, caused by C^{14} , K^{40} , and Ra^{226} , generally constitutes less than $\frac{1}{15}$ of the permissible level." (Chem. Abs. 45: 8059.)

1014. SCHUBERT, J. Estimating radioelements in exposed individuals. III. Bioassay operations and procedures. *Nucleonics* 8(4): 59-67. 1951.

"The lab. must be well isolated. Most samples must first be ashed with concd. HNO_3 . Methods for concn. involve pptn. with carrier, ion exchange, volatilization, electrodeposition, and solvent extrn. Recommended procedures for bioassays for Ra, Pu, Ac, Pa, S, C, the alk. earths, and tritium are given." (Chem. Abs. 45: 8059.)

1015. SCOTT, K. G., and others. Deposition and fate of plutonium, uranium and their fission products inhaled as aerosols. *Amer. Med. Assoc. Arch. Path.* 48: 31-54. 1949.

D. J. Axelrod, J. Crowley, and J. G. Hamilton, joint authors.

The purpose of the experiments described was to ascertain the possible hazards resulting from the inhalation of fissionable materials and fission products. With the exception of one study on a human subject, young rats were used for all the experiments, and after anesthetization were given Pu, U, and mixtures of fission products containing Sr, Y, Zr, Cb, Ru, Ba, La, Ce, Cs, Pr, Nd, and element 61 in the form of smokes and sprays. The rats were given plutonium oxide as smoke, plutonium nitrate as a spray, fission products containing Pu and U as aerosols, carrier-free fission products aerosols, aerosols of carrier-free Zr or zirconium oxide, and aerosols of Pa as protoactinium oxide. The preparation of the aerosols is given in detail. The zirconium aerosol was administered to both a human subject and the rats. It was shown that the aerosols were almost totally retained by the head and lungs immediately after exposure; after 4 days the lungs contained the largest percentage of these elements. The elements deposited in the head and the bronchial tree were quickly eliminated through the gastrointestinal tract, whereas the nonciliated parts of the lungs removed the substances at a slower rate. The main pulmonary site of deposition of the substances was in the bronchial passages and alveoli. A small amount was absorbed and appeared in the skeletal structure, but none was found in the blood vessels or in the lymph nodes.

1016. SHELDON-PETERS, J., and VAUGHAN, J. Analysis of certain chemical constituents of rabbit bone

following deposition of Sr^{90} . *Brit. Jour. Expt. Path.* 37: 553-559. 1956.

"In the bones of rabbits injected with Sr^{90} at about 7 weeks and killed 6 months later, the hydroxyproline content is decreased and hexosamine is increased, both in absolute amts. and in their ratio to bone Ca. With newborn or adult rabbits this effect was not seen and can be explained by the pattern of bone growth during the weaning stage." (Chem. Abs. 51: 9728.)

1017. SILBERSTEIN, H. E. Radium poisoning. U.S. Atomic Energy Comn. AECD-2122, 32 p. 1945.

1018. SULLIVAN, M. F., DOULL, J., and DuBOIS, K. P. Metabolism and toxicity of radioactive metals, IV. Yttrium 91, zirconium 95, columbium 95, strontium 89, and tantalum 182. *Chicago Univ. Toxicity Lab. Quart. Prog. Rpt. 6 on Radiobiol.*, p. 15-36. 1950.

"In 6 days after intravenous administration of yttrium 91 the amount retained in the tissues was 79.4 percent of the initial dose after 1 μ c. and 66.3 percent after 0.5 μ c. Most of the retained yttrium was found in the bones. Orally administered zirconium 95-columbium 95 was not absorbed from the gastrointestinal tract. When given intravenously or intraperitoneally, 50 to 60 percent of the administered tracer doses were retained in the tissues in 6 days. Most of the activity was found in the carcass, although liver, kidney, and spleen also contained significant quantities. Columbium 95 administered orally was absorbed to a greater extent than the other fission products. An average of 10.9 percent of a 4 μ c. dose and 31.9 percent of a 2 μ c. dose was found in the tissues 6 days after administration. When tantalum 182 was administered intravenously as tantalum oxide, about 95 percent of the material remained in the body 6 days after administration to rats. Toxicity tests with tantalum 182 oxide given intraperitoneally to rats have shown that doses of 8 and 16 millicuries/kilogram produced no mortality nor grossly observable toxic effects in 130 days. Strontium 89 was well absorbed from the gastrointestinal tract; 12 to 25 percent of the doses given were absorbed. After intraperitoneal and intravenous administration of strontium 89, the amount present in the tissues in 6 days was 50 to 65 percent of the administered doses." (Author's summary.)

1019. SURMONT, J., and GEST, J. Synthetic bone equivalent to living bone for phantom dosimetry; theoretical, study and realization. *Jour. de Radiol. et d'Electrol.* 38 (5-6): 533-536. 1957.

1020. SWIFT, M. N., PROSSER, C. L., and MIKA, E. S. Effects of Sr^{90} and X-radiation on goats. *Chicago Univ. Metall. Lab. Ch-3888*, 58 p. 1946.

"The 30-day LD_{50} for intramuscularly injected Sr^{90} in goats appears to lie between 1.0 and 1.5 μ c./gram. The rate of excretion of Sr^{90} in urine and feces and the percentage retained vary considerably, but over a range similar to that reported for the dog. Toxicity on the basis of body weight is thus the same or less in the goat than in the dog (30-day LD_{50} , 1.0 μ c./gram. If the goat be assumed representative of the larger mammals, this indicates that the slope of the curve relating animal size to Sr^{90} toxicity does change in the range 30-60 kg., and toxicity is clearly not a simple function of body weight. The clinical course and gross pathology after sublethal and lethal doses are in general similar to those observed in the dog. One subacute anemic death occurred after a mid-lethal dose, however. This type of response has been observed in the dog only after repeated daily doses of X-radiation. The pattern of hematological change is similar in goats and dogs, but the decrease in leucocyte count is noticeably less in nonsurvivors as well as in survivors in the former species. The 30-day LD_{50} for total-body X-radiation in goats is about 350 roentgens, a figure which approximates that obtained for the dog. The post-X-irradiation syndrome is grossly indistinguishable from that after injection of Sr^{90} . There is some indication, however, of a greater depression of the leucocyte count after X-irradiation. Blood-coagulation times

after X-irradiation were erratic and failed to show the definite rise characteristic of the X-irradiation, Sr⁹⁰, and Pu²³⁹ syndrome in dogs." (Author's summary.)

1021. TSUZUKI, M. Radiation injury due to radioactive fallout. Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, Proc. (1955) 11: 132-133. 1956.

1022. UTAH UNIVERSITY, RADIOBIOLOGY LABORATORY. Annual progress report. U.S. Atomic Energy Comm. AECU-3418, 59 p. 1955.

"Progress is reported in studies on the toxic effects of radioactive heavy metals in dogs. Data are included on the pathological effects, metabolism, and bone deposition of Pu, Ra, Ra²²⁴, Ra²²⁶, Th, Th²²⁸, Sr⁸⁵, Sr⁹⁰, Sr⁹⁰, and Y⁹⁰; the effects of irradiation on the skeletal uptake of Sr; the hematological effects of internally deposited Pu and Ra; and the role of Th²²⁸ in Ra poisoning. A list of publications during the period is included." (Nuclear Sci. Abs. 11: 5133.)

1023. VAUGHAN, J. Radiation injury to bone. Lectures Sci. Basis Med. [London] 4: 196-223. 1954-55.

1024. WARD, A. H. Retention and toxicity of radiostrontium in monkeys. Internatl. Jour. Appl. Radiation and Isotopes 2: 234. 1957.

"Experiments with Sr⁹⁰ administered to monkeys from a colony of 80 animals are described. Single doses, ranging from 2 to 0.001 mc./kilogram body weight were given to animals in three experimental groups (high injection dose, low injection dose, and low oral dose) distributed among three species. Relationships between survival time and injection dose are discussed, and the lethal dose for 30-500 days is estimated at 0.70 and 0.01 mc./kilogram body weight, respectively, indicating a higher toxicity in monkeys than in any other animal yet reported. A marked species difference is seen in the toxicity of low injection doses. Excretion and retention of Sr⁹⁰ and Y⁹⁰ are discussed. Excretion is slower from monkeys than from other animals, but varies strongly with the injection dose. Long-term excretion and retention results depart from the logarithmic type of formula usual for short-term results. A comparison with radium excretion and retention in man is given. A much greater percentage of excretion follows oral administration, especially in feces in the first few days, and a tentative comparison with strontium excretion from man is given. The well-known effect of diet calcium level on excretion was measured in monkeys. The surviving monkeys were moved to A.E.R.E. Harwell and investigations are being continued there by a pathologist of the Medical Research Council." (Author's abstract.)

1025. WILSON, C. W. Effect of x-rays on the uptake of phosphorus-32 by the knee joint and tibia of six-week old mice: Relation of depression of uptake to x-ray dose. Brit. Jour. Radiol. 29: 571-573. 1956.

"The variation with time after irradiation of the resultant depression of P³² uptake in the knee joint and tibia of 6-week-old mice is studied for doses of 1000-2000 r. Max. depression is produced in the knee joint during about 4-8 weeks after irradiation and the relation between this and the dose producing it is examd. At least up to a dose of 2000 r. the relation is linear. This basic information may now be used to exam. the effects of such factors as 0 tension or administered chem. substances." (Chem. Abs. 51: 2898.)

1026. WILSON, C. W. The uptake of phosphorus-32 by the knee joint and tibia of six-week-old mice and the effect of x-rays upon it. Variation of uptake with time after a dose of 2000 r. of 200-kilovolt x-rays. Brit. Jour. Radiol. 29: 86-91. 1956.

"Expts. are described which examine the effect of a single x-ray dose of 2000 r. to the knee joint and tibia of 6-week-old mice upon the uptake of P³² in these bones at varying intervals after irradiation up to 22 weeks. In the knee joint, after a latent period of about 1 week the uptake

of P³² falls progressively to reach a min. value of about 55% after about 4 weeks. The time sequence of the irradiation effects involved may be suppression of osteoblastic activity leading to immediate and increasing depression of alk. phosphatase activity as a result of which, after the latent period, new calcification is depressed in increasing amt. until the max. is reached. This depression is maintained until about 8-10 weeks after irradiation following which a slow recovery seems to occur, but this is still incomplete at the end of 22 weeks. In the tibia similar effects of a similar magnitude were observed but they develop more slowly. This difference may be related to differences between the growth activity of the knee joint and tibia." (Chem. Abs. 50: 14069.)

1027. WOODARD, H. Q. Some effects of X-rays on bone. Clin. Orthopaedics 9: 118-130. 1957.

1028. WOODARD, H. Q., and LAUGHLIN, J. S. Effect of X-rays of different qualities on the alkaline phosphatase of living mouse bone. II. Effects of 22.5 m.e.v. X-rays. Radiation Res. 7: 236-252. 1957.

"The previous study on male mice was extended to females where the abs. loss in phosphatase activity was slightly greater. The relative biol. effectiveness of X-rays for phosphatase loss, integrated over the first 50 days after exposure was: 180 e.k.v., 1.00; 1000 e.k.v., 1.02; and 22.5 m.e.v., 1.09." (Chem. Abs. 52: 2973.)

CARCINOGENICITY

1029. ANDERSON, W. A. D., and ZANDER, G. E. The pathologic effects of radioactive calcium and strontium on the bones of CF₁ mice. U.S. Atomic Energy Comm. AECU-2624, 11 p. [n.d.]

"Ca⁴⁵ injected intraperitoneally as single doses of 3.5 or 5 μ c./gram or weekly doses of 0.6 or 2.1 μ c. administered for about a year resulted in the production of bone tumors in mice. Smaller doses produced no tumors. Bone tumors were also obtained in mice that received weekly doses of 1.5 or 2.1 μ c. Sr⁹⁰ for about 6 months. Autoradiographs demonstrated less radioactivity in the tumor tissue than in the intact bone." (Author's abstract.)

1030. ANDERSON, W. A. D., ZANDER, G. E., and KUZMA, J. F. Cancerogenic effects of calcium-45 and strontium-89 on bones of CF₁ mice. Amer. Med. Assoc. Arch. Path. 62: 262-271. 1956.

"Ca⁴⁵ in a single or in several weekly doses causes osteogenic sarcoma in mice, mostly in the spine and pelvis; out of 20 mice receiving the largest dose (105.7 microcuries) 6 developed tumors. Sr⁹⁰ in multiple doses acts similarly." (Chem. Abs. 51: 3792.)

1031. AUB, J. C., and others. Late effects of internally deposited radioactive materials in man. Medicine 31: 221-329. 1952.

R. D. Evans, L. H. Hempelmann, and H. S. Martland, joint authors.

1032. BELOBORODOVA, N. L., and BARANOVA, E. F. Radiotoxic effect of radioactive strontium in chronic experiments. Mater. Toksikol. Radioaktiv. Veshch. (Moscow: Gosud. Izdatel. Med. Lit.) Sborn. 1957 (1): 151-162. 1957.

"Animals which received Sr⁹⁰ for a period of 36 months showed signs of progressive destruction of the hemopoietic system." (Chem. Abs. 52: 2262.)

1033. BLOOM, M. A., and BLOOM, W. Late effects of radium and plutonium on bone. Amer. Med. Assoc. Arch. Path. 47: 494-511. 1949.

"Radium (0.3-0.03 microcurie/g.) injected into mice produces an overgrowth of the femurs and the vertebrae, starting in the metaphysis and spreading. The new bone is fibrous and atypical. Many empty lacunae are present. The changes after plutonium (0.03-0.003 microcurie/g.) are similar, but the thickened trabeculae of spongy bone are more compact, and there are few empty lacunae.

Atypical proliferations were seen after some months." (Chem. Abs. 49: 7135.)

1034. BRUES, A. M., LISCO, H., and FINKEL, M. P. Carcinogenic action of some substances which may be a problem in certain future industries. *Cancer Res.* 7: 48. 1947.

"An investigation is under way to test the late or chronic effects of exposure to plutonium and products of U fission on rats, mice, rabbits, and dogs. Effects of Ra were also studied for comparison. Sr^{90} , with a 55-day half life and a tendency to become concd. in bone, produced bone tumors, slightly increased the incidence of lymphoma, and did not affect mammary tumor incidence. Ra produced bone tumors and heavy calcification in the media of the larger arteries and certain other sites. Ce^{144} - Pr^{144} caused bone sarcoma and atrophy of the liver except in the marginal areas where ionization was less and regeneration could proceed. Y^{91} , fed by stomach-tube, was virtually unabsorbed; 0.1 of the acute lethal dose was fed daily for 3 months with no measurable detriment, but animals surviving this treatment as well as those surviving a single acute dose of 20-30-mc./kg. showed after several months a variety of intestinal lesions with obstruction. Plutonium (Pu^{239}), injected intravenously, became most concd. at first in liver and spleen, was later translocated to bone. Acute plutonium was similar to acute total body radiation sickness, with the addn. of splenic atrophy and gross liver changes. Chronic plutonium involved hair graying, progressive liver damage, and bone sarcoma. After subcutaneous injection of 1γ of Pu^{239} , local fibrosarcomas appeared within 1 year, and local epilations, ulceration, keratoses, and spontaneous amputation also occurred." (Chem. Abs. 41: 4226.)

1035. BURYKINA, L. N. The chronic action of small doses of radioactive strontium on dogs. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., *Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 61-65. Moscow, State Medical Literature Press, 1956.

1036. CHERKASKII, L. A. Bone change in rats after the injection of radioactive strontium. *Voprosy Onkologii* 2: 275-284. 1956.

" Sr^{90} was used as the source of β irradiation. Rats were injected with 0.25-9.0 microcuries/g. of animal body wt. Some types of general bone changes developed in all rats but at different time periods, depending upon the duration of expt., age and individual biocharacteristics of the animals. Necrobiosis and necrosis of the hemopoietic cells and of the osteocytes were among the early appearing symptoms. The damage extended over all the hemopoietic elements of the bone marrow, in extensive areas of the metaphyses sections of the tubular bone structures and of the facial skull bones in particular. In some cases the hemopoietic elements of the metaphysal sections only were destroyed; in other cases small foci of necrosis of bone marrow appeared along the entire length of the bone, and the few osteocytes completely disappeared. After tissue damage the process of fibrosis may set in, not as replacement of the dead tissues, but as irradiation-stimulated connective tissue proliferation. These fibrous changes are localized most frequently in the metaphyses. The type of the newly developed connective tissue may differ in one and the same animal. The changes which occur and the regeneration processes which take place in bone tissue and bone marrow are described in detail." (Chem. Abs. 51: 3032.)

1037. CHERKASKII, L. A. Cancer of the hard palate and gums in white rats induced by internal irradiation. *Voprosy Onkologii* 2: 614-617. 1956.

1038. CLEMEDSON, C. J., and others. The skeleton and radioactive poisoning from products of ionization. *Svenska Läkartidningen* 53: 861-867. 1956.

B. Engfeldt, A. Engstrom, and A. Nelson, joint authors.

1039. FINKEL, M. P. Internal emitters and tumor induction. *Internatl. Conf. Peaceful Uses Atomic Energy*, Geneva, Proc. (1955) 11: 160-164. 1956.

1040. FINKEL, M. P., and others. Radiostrontium at optimum carcinogenic level in the dog: Effect upon morbidity of total blood exchange shortly after injection. *U.S. Atomic Energy Comm. ANL-5732*, p. 15-20. 1957. R. J. Flynn, J. Lestina, and D. M. Czajka, joint authors.

1041. FINKEL, M. P., LISCO, H., and BRUES, A. M. Toxicity of Sr^{90} in mice, tumors among the control animals. *U.S. Atomic Energy Comm. ANL-5288*, p. 23-34. 1954.

This report deals with tumors that appeared among control animals during a long-term radiostrontium study in mice and with some problems involved in deriving the most useful and accurate information from tumor data.

1042. FITZGERALD, P. J. Radioautography in cancer. *Cancer [Phila.]* 5: 166-194. 1952.

"Review with 267 references covering the uses of radioactive elements (P^{32} , I^{131} , C^{14} , S^{35} , and others) in exptl. and clinical studies." (Chem. Abs. 46: 3110.)

1043. HASTERLIK, R. J. The delayed toxicity of radium deposited in the skeleton of human beings. *Internatl. Conf. Peaceful Uses Atomic Energy*, Geneva, Proc. (1955) 11: 149-155.

1044. HOECKER, F. E., and ROOFE, P. G. Studies of radium in human bone. *Radiology* 56: 89-98. 1951.

"Portions of several different bones from 2 cases of osteogenic sarcoma attributed to radioactive substances in the bones have been examd. microscopically and autoradiographically. The radioactive substances (chiefly Ra and its disintegration products) are found to be concd. in numerous microscopic localizations. The max. d of Ra in these localizations appears to vary by a factor of only about 1.5 from one type of bone to another, but the frequency of occurrence of these localizations may vary by a factor of nearly 25. Certain regions of some bones may be entirely devoid of Ra. The mineral residue of the sarcoma of one case contained only a negligible amt. of Ra. Ra was not mobilized from other portions of the body, although this apparently did occur in the case of Ca. This indicates that Ra is not biochemically similar to Ca in all respects." (Chem. Abs. 45: 3071.)

1045. HUNT, H. B. Role of radioisotopes in blood dyscrasias and neoplastic diseases. *Tex. State Jour. Med.* 46: 496-503. 1950.

"A lecture." (Chem. Abs. 44: 10880.)

1046. KARNOFSKY, D. A. Chemotherapy of neoplastic disease. I. Methods of approach. II. Trend in experimental cancer therapy. *New Eng. Jour. Med.* 239: 226-231, 260-270. 1948.

"A review with 213 references. Among the subjects discussed are the basic ideas, lab. techniques, and clinical testing of agents for chemotherapy of cancer, and the status of each of the following: *biol. products*—Coley's mixed toxins, Shear's polysaccharide (from *Bacillus prodigiosus*), crude penicillin, other mold products, K-R (*Trypanosoma cruzi* endotoxin); *urine and tissue preps.*—H.11 (normal human urine ext.), myelokentric acid (from urine of patients with myelogenous leukemia), splenic exts., antireticular cytotoxic serum; *vitamins and their antagonists*—avidin, *p*-aminobenzoic acid, desoxyypyridoxine, pteroyltriglutamic acid (teropterin) and other compds. related to folic acid; *hormones*— α -bromo- α,β,β -triphenylethylene, other estrogens, adrenocortical hormones; *cell poisons*—N mustards, urethan, colchicine, podophyllin; *carcinogenic agents found to inhibit some types of cancer*—1,2,5,6-dibenzanthracene, 1,2-benzopyrene, 9,10-dimethyl-1,2-benzanthracene, aminostilbenes; *radioactive substances*—radioactive P, I, Sr, Mn, Au, Na; and *miscellaneous substances*—dyes, heptaldehyde, stilbamide, and enzyme poisons." (Chem. Abs. 42: 7880.)

1047. KHADAIDE, L. L. Development of tumors at the place of introduction of radioactive substances. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 40-44. Moscow, State Medical Literature Press, 1956.

1048. KRUMHOLZ, L. A., and RUST, J. H. Osteogenic sarcoma in a muskrat from an area of high environmental radiostrontium. Amer. Med. Assoc. Arch. Path. 57: 270-278. 1954.

"The case of an osteogenic sarcoma in a muskrat (*Ondatra zibethica*) feeding on plants with large amounts of radiostrontium is reported. The total dose received is calculated to be at the rate of 40 r.e.p. per day. The tumors involved the right tibiofibula and were of the sclerosing type. There were metastases to the kidneys and lungs." (Author's summary.)

1049. KUZMA, J. F., and ZANDER, G. E. Cancerogenic effects of Ca^{45} and Sr^{90} in Sprague-Dawley rats. Amer. Med. Assoc. Arch. Path. 63: 198-206. 1957.

" Ca^{45} and Sr^{90} (in 10 daily or 10 monthly injections) produce osteogenic sarcomas in rats; Sr^{90} is the most effective. The neoplasms occur mostly at the ends of the long bones, but Ca^{45} caused some in the pelvis and spine. Squamous cell carcinomas can arise where the bone contg. Sr^{90} is in close proximity to the squamous epithelium. Benign exostoses occurred in some animals, mostly after Ca^{45} ." (Chem. Abs. 51: 10711.)

1050. LAWRENCE, J. H. Observations on the nature and treatment of leukemia and allied diseases. Chicago Inst. Med. Proc. 14: 30-49. 1942.

1051. LISCO, H., FINKEL, M. P., and BRUES, A. M. Carcinogenic properties of radioactive fission products and of plutonium. Radiology 49: 361-363. 1947.

"A total of 1 γ of Pu or 1 millicurie of YPO_4 injected under the skin induced fibrosarcomas even though a certain portion of the injected dose was removed from the site of injection and was distributed throughout the body and partially excreted. Bone tumors appeared in animals injected with Pu at levels ranging from 4.5 to 0.05 γ per g. The min. latent period was 200 days. The majority of Pu-induced tumors occurred in the spine, often producing hindleg paralysis and urinary retention as first symptoms. Carcinoma occurred in the colon of rats fed Y^{91} ." (Chem. Abs. 42: 266.)

1052. LITVINOV, N. N. Dynamics of the development of bone sarcomas originating under the influence of radioactive substance. Voprosy Onkologii 3: 285-294. 1956.

1053. LITVINOV, N. N. Dynamics of the formation and development of bone sarcomas after damage by radioactive strontium and yttrium. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 47-50. Moscow, State Medical Literature Press, 1956.

1054. LITVINOV, N. N. The mechanism of development of bone sarcomas as a result of treatment with radioactive substances. Voprosy Onkologii 2: 285-294. 1956.

"White mice 160-180 g. were injected intraperitoneally with a soln. of Sr^{90} salt in 0.4 microcurie/kg. dose. Animals were sacrificed 1-200 days after injection. In the metaphyses of the tubular bones of white rats injected with Sr^{90} as specified above, there developed profound chronic changes of the life processes of the bone tissues which in many cases resulted in the formation of malignant growths. Such changes are expressed as progressive disturbances of

the processes of bone formation (dysplasia) with the progressive rate of formation of immature atypical cells of the bone structure. Two to three months after the injection of the Sr^{90} disturbances in the process of osteogenesis go through a phase of formation of incomplete fibrous and amorphous structure followed by a process of formation of cellular elements. Changes occurring 4-5 months after Sr^{90} irradiation are described. At the end of the 5th and the beginning of the 6th month after Sr^{90} injection the growth of the atypical immature bone structure assumes the character of a tumor which fills in the bone marrow cavity of the metaphyses and penetrates through the destroyed cortical substance outside of the bone." (Chem. Abs. 51: 2176.)

1055. LOONEY, W. B. Late clinical changes following the internal deposition of radioactive materials. Ann. Int. Med. 42: 378-387. 1955.

"Almost all of the Ra is eliminated when taken into the body. The retained Ra is deposited irregularly in the skeleton in small areas of high Ra concn. Röntgenographic changes characteristic of radioelement deposition develop many years after deposition. Areas of decreased density occur in compact bone as a result of bone destruction. Areas of increased density occur in cancellous bone as a result of atypical osseous tissue formation. Areas of decreased density on skeletal röntgenographic examn. may be the first clinical evidence of malignancy. Almost all of administered Th is indefinitely retained. The primary sites are liver, spleen, and bone marrow, with less in the lungs, adrenals, etc. No relation can yet be shown between Th and malignancies. 37 references." (Chem. Abs. 49: 7125.)

1056. LOONEY, W. B. Late effects (twenty-five to forty years) of the early medical and industrial use of radioactive materials. Their relation to the more accurate establishment of maximum permissible amounts of radioactive elements in the body. Part I. Jour. Bone and Joint Surg. 37-A: 1169-1187. 1955.

"Radium deposited in the skeleton usually initiates a sequence of events that eventually produces pathological changes. These changes are probably the end result of many intermediate factors such as trauma, damage to blood supply, hormonal imbalance, decreased bone repair, and increased bone destruction from other causes. Evidence from the histological sections indicates that Haversian systems may undergo periods of resorption followed by periods of bone formation (fig. 17). There was a subnormal appearance of the bone in many instances. Some of the destructive changes may be the result of the inability of bone to maintain normal repair. It is evident that the relationship between radium deposition and skeletal change is complex. It is reasonable to conclude that when the destructive effects of radium and other deleterious intermediate factors become greater than the reparative processes of the skeleton, permanent alterations occur." (Author's summary.)

1057. LOONEY, W. B., and others. A clinical investigation of the chronic effects of radium salts administered therapeutically (1915-1931). Amer. Jour. Roentgenol., Radium Ther., and Nuclear Med. 73: 1006-1037. 1955.

R. J. Hasterlik, A. M. Brues, and E. Skirmont, joint authors.

"In the United States, there are perhaps a thousand individuals who were given Ra salts parenterally or orally 20 or more years ago. For the most part, these persons are unaware that they carry Ra deposits. Hematologically, the findings in these patients are neither striking nor diagnostic of Ra poisoning. The usual hematologic criteria of radiation damage to the erythropoietic system, such as abnormalities of the total white blood cell count and a typical appearance of the white blood cells, did not differentiate in this series between those individuals carrying a very small and a very large body burden of Ra. Moderate anisocytosis and poikilocytosis of the red blood cells seemed to be const. findings in those individuals carrying more than 2 gamma of Ra. An analysis of several thou-

sand roentgenograms made on 38 individuals who received Ra therapeutically and 6 individuals who had been employed as radium dial painters demonstrates a general correlation between the level of body burden of Ra and the frequency and severity of osseous lesions." (Chem. Abs. 49: 12701.)

1058. LOW-BEER, B. V. A., LAWRENCE, J. H., and STONE, R. S. The therapeutic use of artificially produced radioactive substances; radiophosphorus, radiostrontium, radio-iodine, with special reference to leukemia and allied diseases. *Radiology* 39: 573-597. 1942.

"Radioactive P in Na acid phosphate has proved to be of great value in the treatment of chronic lymphatic and myelogenous leukemias, polycythemia vera, and lymphosarcoma. Its use in the treatment of Hodgkin's disease is not yet established by experience. In the opinion of the authors its place in the treatment of multiple myeloma, metastatic carcinoma and some other conditions is not well established, but the inevitably fatal outcome of these diseases justifies its exptl. trial. The authors state furthermore that the use of other radioactive elements (Sr, I, element 85, and P in chromium phosphate) is proving of value in some conditions. The article stresses the difficulties in dosimetry in this new type of radiation therapy. A means of calculating the "radiation level" in the body of a patient on any day after either one dose or multiple doses of radio-phosphorus is described. Case histories and a bibliography covering 66 papers complete this interesting report on the latest achievements in radiation therapy." (Biol. Abs. 17: 10807.)

1059. MAKARYCHEVA, R. I. Dynamics of the formation and development of experimental osteogenic sarcomas. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., *Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 45-46. Moscow, State Medical Literature Press, 1956.

1060. PECHER, C. Biological investigations with radioactive calcium and radioactive strontium. Simultaneous production of a radiostrontium for therapeutic bone irradiation and a radio-yttrium suitable for metallic radiography. *Jour. Applied Phys.* 12: 318-319. 1941.

1061. PECHER, C. Biological investigations with radioactive calcium and strontium: Preliminary report on the use of radioactive strontium in the treatment of metastatic bone cancer. *Louisville Univ. Sch. Med. Pharmacol. Pub.* 2: 117-149. 1942.

"Radioactive Ca^{45} and Sr^{89} were prepared by bombardment of Ca^{44} and Sr^{88} , resp., with 16-m.e.v. deuterons in a 60-in. cyclotron, and were used as their lactates in dosage sufficiently small to avoid any influence on the metabolism. The exptl. animals were mice, rats, and rabbits. When Ca^{45} and Sr^{89} were injected intravenously, they rapidly concd. in the skeleton; after 24 hrs., the radioactivity per g. wet wt. was approx. 100 times lower in the soft tissues than in the bones, and the lowest activity occurred in the liver and the fat. The highest concn. of radioactive isotope was in the region where new bone or dentine was being formed (roots of the teeth, epiphyseal line, fractured bone). Trabecular bone showed a higher radioactivity per mg. of $\text{Ca}_3(\text{PO}_4)_2$ than did the shaft of a long bone. Comparison of the skeletal uptake of these radioactive isotopes after their oral administration and after their intravenous injection showed that approx. 30% of the ingested compd. was absorbed. Intestinal absorption of Sr and its uptake by the bones was independent of the anion (Cl, lactate, gluconate). After their intravenous injection, Ca^{45} and Sr^{89} were excreted in both the urine and the feces, in mice a large fraction was in the feces. Sr^{89} apparently was excreted approx. equally in urine and feces in rats, but to a greater extent in the urine in man. In preliminary expts. on the therapeutic irradiation of neoplastic diseases generalized to the skeleton especially osteogenic tumors, e.g.,

osteogenic sarcoma and bone metastasis from carcinoma of the prostate, Sr^{89} was administered intravenously as a soln. of its lactate contg. 20 mg. of cation per cc.; total doses as high as 10 microcuries were administered with apparently no ill effects after 6 months. The resulting irradiation of the soft tissues was negligible as compared with that of the bone. The dosage of Sr was non-toxic; no histological modification of normal bone structure resulted; a transitory leucopenia and anemia occurred. The radiation became most concd. in regions where an osteoblastic process existed. 12 references." (Chem. Abs. 37: 946.)

1062. PETROVICH, I. K. Changes in the blood picture in animals at long intervals after introduction of radioactive substances into the organism. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A., eds., *Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 9-11. Moscow, State Medical Literature Press, 1956.

1063. POBEDINSKII, M. N. Reaction of bone tissue to roentgen irradiation and to radioactive substances. *Vest. Khirurgii im. Grekova* 76: 116-121. 1955.

1064. SCHWARTZ, S. S., and others. Studies of liver function in experimental animals with special reference to radiation and metal exposure. *U.S. Atomic Energy Comm. NYO-4656*, p. 390-410. 1956.

L. Schneider, L. M. Porter, M. Tinsley, and J. Wallace, joint authors.

1065. SHIKHODYROV, V. V. Changes in loose connective tissue in chronic radiation sickness. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., *Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 25-28. Moscow, State Medical Literature Press, 1956.

1066. SIMMONS, E. L., and JACOBSON, L. O. Radio-toxicity of injected Sr^{89} for rats, mice and rabbits. Part IV. Hematological effects of internally and parenterally administered strontium-89 in mammals. *Chicago Univ. Metall. Lab. Ch-3797*, 60 p. 1946.

"Tracer studies of the distribution of Sr^{89} in animals have been reported. They indicate a rapid localization to bone after intraperitoneal injection or after ingestion. Studies in this laboratory in which larger than tracer amounts were used have essentially corroborated these previous findings. No publications have come to our attention in which controlled studies of the hematological effects of this radioactive isotope were made. Other radioactive isotopes that localize largely in bone have been investigated in terms of their hematological effect; these include radium and plutonium. Once deposited within the body, the biological effects of these latter elements are almost exclusively due to alpha particle emissions. Strontium 89, which emits beta rays only, has a relatively short half life (55 days) compared to radium and plutonium, but in view of the specificity of bone localization of all three, a study of hematological effects provides a useful biological comparison." (Author's abstract.)

1067. STRELTSOVA, V. N., and MOSKALEV, Y. I. Remote consequences of single and chronic intake of radioactive isotopes (Ce^{144} , Ru^{106} and $\text{Sr}^{89,90}$) and a mixture of beta emitters through the gastrointestinal tract. In Kortkov, F. G., Lebedinsky, A. V., and Ignatyev, A. I., eds., *Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 36-39. Moscow, State Medical Literature Press, 1956.

1068. TRUSOVA, N. E. Influence of ionizing radiation on the activity of dog spermatozoa. In Kortkov, F. G.,

Lebedinsky, A. V., and Ignatyev, A. I., eds., Summaries of papers presented at the Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation, report of the Committee on Medical Radiology, Ministry of Health, U.S.S.R., p. 51-53. Moscow, State Medical Literature Press, 1956.

1069. WEESE, K. Origin of bone formation in bone-containing metastases of carcinoma. *Virchows Arch. f. Path. Anat. u. Physiol.* 329: 1-12. 1956.

"Islets of bony tissue can be found in many varieties of carcinomatous metastasis. These arise anew from embryonic type mesenchymal cells which are pluripotent. The embryonic tissue can become either osteoplastic or osteoclastic." (*Internatl. Abs. Biol. Sci.* 6: 1344.)

1070. WOODARD, H. Q., and PHILLIPS, R. Mineral content of bone tumors and its influence on radiation tumor dose. *Amer. Jour. Roentgenol., Radium Ther., and Nuclear Med.* 78: 109-115. 1957.

"The most heavily calcified portion of a bone sarcoma is the least active; calcification is usually 5-20% that of normal bone. The use of short γ -radiation will be most effective in controlling the tumor and least damaging to normal bone." (*Internatl. Abs. Biol. Sci.* 8: 954.)

METHODS OF REMOVAL OF RADIOSTRONTIUM FROM THE ANIMAL BODY

1071. BONATI, F., and CUCURACHI, L. Excretion of ethylenediamine tetraacetic acid and calcium balance in the administration of ethylenediamine tetraacetic acid calcium disodium salt by venous and rectal route. *Gior. di Clin. Med.* 37: 934-949. 1956.

1072. CH'EN, J. S., and FREEMAN, S. The removal of cations from solutions and the rat's alimentary canal by H-form resins. *Jour. Lab. and Clin. Med.* 35: 99-110. 1950.

"Expts. on the combining capacities of the cation-exchange resins, Nalcite HCR, Duolite C-3, and Amberlite IR-100H indicate that the first mentioned one is most efficient as judged by the uptake of Na, K, and Ca from soln. The method of drying a resin may have an important bearing on the accuracy of the results. Vacuum desiccation over a dehydrating agent is more satisfactory than oven drying at 80°. Na, K, and Ca can be removed from the animal body in significant amts. by the ingestion of cation-exchange resins. The relative affinity of the resin for different cations and the cation content of the diet both influence the extent to which various cations will be removed from the body by resin. The *in vitro* and *in vivo* uptake of Na by H-form resins is suppressed by Ca and K ions. A high Ca content in the diet markedly interferes with the uptake of K and Na by the resin. These expts. indicate that it may be possible to remove selectively cations from the body by proper control of the cation content of the diet and the form and amt. of ingested resin." (*Chem. Abs.* 44: 3553.)

1073. CLARKE, N. E., CLARKE, C. N., and MOSHER, R. E. The *in vivo* dissolution of metastatic calcium. An approach to atherosclerosis. *Amer. Jour. Med. Sci.* 229: 142-149. 1955.

"Disodium ethylenediaminetetraacetate (EDTA, I) given intravenously to 22 patients with angina pectoris, nephrocalcinosis, rheumatoid arthritis, diabetic neuroretinitis, peripheral vascular disease, indolent ulcer with extensive Ca metastasis in the neck, neuromuscular diseases, calcified mitral stenosis, and otosclerosis, proved reasonably safe in dosage of 5 g./day, dissolved in 500 cc. of 5% glucose or normal saline soln., given by drip infusion during 1.5-3 hrs.; 10-100 (av. 50) infusions were given per patient. Toxic reactions included burning at the injection site, nausea, diarrhea, abdominal cramps, and dermatitis; these were reduced by oral administration of pyridoxine. The disodium salt was preferred for the infusions after use of the K salt was found to cause intense burning at the

injection site. Serum Ca levels of the patients receiving I were approx. the same before and after I administration, when analyses were made by permanganate titration of ppt. obtained by treating wet-ashed serum (after nitric-perchloric acid treatment to destroy I) with oxalate. Analyses made by direct pptn. of serum Ca with oxalate yielded lower values after I administration than before it, but are believed to be unreliable because of the presence of I inhibits Ca oxalate pptn. Metastatic Ca deposits in the kidney of the patient with nephrocalcinosis were markedly reduced by I administration. This patient also showed striking improvement and hearing, indicating that I can favorably influence otosclerosis and deafness. The results suggest that I produces a Ca imbalance leading to dissolution of Ca deposits, but not reflected in serum-Ca levels because serum Ca removed by I is replenished by Ca from metastatic deposits. Possible interrelations between Ca, cholesterol or lipoproteins, and atheromatous changes in arterial walls are discussed. Clinical results in angina pectoris and the other diseases noted above will be published later." (*Chem. Abs.* 49: 16223.)

1074. COHN, S. H. The effect of chemical agents on the skeletal content and excretion of internally deposited fission products. U.S. Atomic Energy Comm. ANL-5584, p. 144-149. 1956.

"During a control period of 5 days, 24-hr. urine samples were collected daily for radioanalysis in order to establish a basal excretion rate. During the next 3 days the Ca salt of ethylenediaminetetraacetic acid (EDTA) was administered orally daily, 1 g./25 lb. body wt. Twenty-four hr. urine samples were collected daily during the treatment period and for 5 days following treatment. No side effects from the use of this EDTA salt were observed. Blood counts and blood pressure remained unchanged throughout the treatment. The mean radioactivity in the urine following EDTA treatment was about 2.5 times the pretreatment activity. Thus, the oral administration of EDTA for a period of 3 days beginning 52 days post detonation slightly increased the excretion rate of internally deposited fission products. The over-all effect on decreasing the body burden in this situation, however, was insignificant as the excretion rate was very low at this time." (*Chem. Abs.* 51: 4557.)

1075. COHN, S. H., and GONG, J. K. Effect of chemical agents on skeletal content and excretion of injected strontium-89. *Soc. Expt. Biol. and Med. Proc.* 83: 550-554. 1953.

"Administration of salts of ethylenediaminetetraacetic acid (EDTA) under the most favorable conditions for its action had no effect on skeletal distribution of injected carrier-free Sr^{89} in rats. Zr citrate given prior to injection of Sr^{89} resulted in a level of Sr^{89} in the skeleton at 5 days 40% lower than in controls. Sr^{89} excretion was increased. Administration of EDTA or BAL with Zr citrate did not modify its effect." (*Chem. Abs.* 47: 12631.)

1076. COUNE, F. L., and DRIGGERS, J. C. The influence of ethylenediamine tetraacetic acid on serum calcium in male chickens. *Poultry Sci.* 33: 1005-1009. 1954.

"Rapid intravenous injection of 200 mg. EDTA/kilogram of body weight lowered serum Ca to a fatal level in all cases. Intraperitoneal, intramuscular, or subcutaneous injection of the same amount did not lower serum Ca to fatal levels. Ca gluconate prevented a fatal lowering of serum Ca when injected either simultaneously or in the mixture with the EDTA." (Author's abstract.)

1077. CRAMER, C., and COPP, D. H. Effect of mineral deficient diets on the excretion of radiocalcium and radiostrontium. *Amer. Jour. Physiol.* 167: 776. 1951.

The effects of such regimens on the excretion of radiocalcium and radiostrontium from the skeleton were studied in young (21-day-old) and mature (6-12 months) female rats. Normal animals were injected intraperitoneally with 5 microcuries of radiocalcium or radiostrontium. Rats restricted to a diet low in phosphorus showed a marked

increase in urinary excretion of both radiocalcium and radiostrontium. In contrast, the low calcium diet was associated with a reduction in the excretion of radiocalcium.

1078. DENTZER, G. Studies of calcium and magnesium complexes of disodium ethylenediaminetetraacetate. Arch. f. Expt. Path. u. Pharmacol. 226:140-151. 1955.

"Expts. with the isolated frog heart showed that the Ca complex can not replace CaCl_2 in the Ringer soln. and the Ca ions liberated from the complex amount to less than 1%. Intravenous injection of Ca complex did not influence the Mg narcosis in the mouse. Tests on the frog heart, the phrenicus-diaphragm prep. of the rat, and for blood pressure response in the cat showed that the action of the Mg complex is based on binding of Ca ions in the organism with corresponding release of Mg ions. As the organism reacts to the removal of Ca ions more readily than to the supply of Mg ions, poisoning with Mg complex shows primarily signs of Ca deficiency." (Chem. Abs. 49: 14183.)

1079. EGGERS-LURA, H. Metal chelation and its significance in future caries investigations. Deut. Zahnärztliche Ztschr. 11: 543-551. 1956.

"The concept of chelation and its application to bone histology are discussed. It is pointed out that destruction of tooth tissue by cane sugar can take place without acid action; neutralised cyclic degradation compounds can form at neutral pH. It is now possible to see how organic and inorganic components can be destroyed at the same pH. Cane sugar has no greater acid-forming potentiality than other carbohydrates but has this special complex-forming property with Ca." [German.] (Internat. Abs. Biol. Sci. 7: 2187.)

1080. ELLIOTT, J. R., and TALMAGE, R. V. Influence of citrate on removal of calcium and strontium by peritoneal lavage. Fed. Proc. 17: 41. 1958.

"Recent studies from this laboratory utilizing the technique of peritoneal lavage indicated that exogenous citrate was able to remove stable and radioactive calcium from the bones of rats in the presence or absence of the parathyroid glands. The disproportionately small amounts of Ca^{45} as compared to Ca^{40} removed by lavage by the citrate when radioactivity was injected within 24 hours of the lavage indicated that citrate mobilized calcium from deeper areas of bone. To substantiate this effect of citrate, these experiments were repeated utilizing Sr^{85} . In a further attempt to delineate the areas of bone affected by citric acid, additional studies were done in which radiocalcium or radiostrontium was injected 2-3 weeks prior to peritoneal lavage. When either radioisotope was injected within 24 hours of lavage, the inclusion of 25 mg. of citrate per 100 ml. of rinse solution caused an increase in the amounts of calcium removed from both nephrectomized and parathyroidectomized-nephrectomized rats without significantly increasing the radioactivity removed. When these experiments were performed on animals in which either isotope had been injected 2-3 weeks prior to lavage treatment, both calcium and radioactivity were increased by the administration of citrate. There were no qualitative differences between the removal of the two isotopes. These experiments again suggest that citric acid removes calcium from the areas not readily accessible to injected radioactivity." (Author's abstract.)

1081. FOREMAN, H. The use of chelating agents for accelerating excretion of radioelements. Jour. Amer. Pharm. Assoc. 42: 629-632. 1953.

"The urinary excretion of Y and Pu (I) was accelerated by the administration of Ca ethylenediaminetetraacetic acid and that of I by Fe-3, a com. chelating agent. All methods of administration of the agent (intraperitoneal, intragastric, or intramuscular) produced the same effect." (Chem. Abs. 48: 285.)

1082. GRAUL, E. H., and HUNDESHAGEN, H. Absorption and removal of radioactive fission products in

the body. Ztschr. f. Aerosol-Forsch. u. Ther. 6: 95-104. 1957.

"Guinea pigs injected with Sr^{90} as $\text{Sr}^{90}\text{Cl}_2$ after 5 days had concd. the Sr^{90} in the epiphysal bone growth zones. Y^{90} concd. in the pancreas within 1-4 days after injection as Y^{90}Cl_3 . Two guinea pigs given Y^{90} orally as Y^{90}Cl_3 concd. the radioactive element in the pituitary after 4 days. The urinary excretion of Sr^{90} by guinea pigs injected with it as $\text{Sr}^{90}\text{Cl}_2$ was much increased by medication with Parathormone, and increased further by medication with this hormone plus the Ca salt of ethylenediaminetetra-carboxylic acid." (Chem. Abs. 52: 8367.)

1083. GREENBERG, D. M. Proposed procedure for study of removal of long life fission products from the body. U.S. Atomic Energy Comm. MDDC-1143-E, 3 p. 1947.

A group of proposed procedures for the study of removal of long life fission from the body has been compiled.

1084. GREENBERG, D. M., and KAPLAN, N. A preliminary study of the removal of radiostrontium (Sr^{85}) from the body. U.S. Atomic Energy Comm. MDDC-1142-E, 5 p. 1947.

Preliminary experiments on removal of Sr^{85} from rats have indicated that sodium citrate, parathyroid hormone, ammonium chloride, and strontium chloride all apparently slightly enhance the removal of Sr^{85} . Massive doses of irradiated ergosterol have no such effect.

1085. HAMILTON, J. G. Metabolism of fission products. U.S. Atomic Energy Comm. MDDC-1142, 12 p. 1943.

Methods of preparation without carrier and results of tracer studies on animals with La^{140} , Ce^{140} , Sr^{85} , and unseparated fission products are given. Experimental results on the preliminary study of the removal of Sr^{85} from bodies of rats are given.

1086. HUNZINGER, W. A., and ORTELLI, G. A. Ca excretion after calcium disodium ethylenediaminetetraacetate in man. Schweiz. Med. Wchnschr. 84: 1339-1341. 1954.

"Eight patients in variable Ca status maintained under metabolic conditions on a constant Ca diet intake of 330 mg./day were given 100 mg. of Ca i.v. as Ca di-Na EDTA. An average of 70% of the infused Ca was recovered in the urine in the 24 hours following the infusion of this tightly bound Ca chelate. Ca^{45} infused as the chelate was rapidly exchanged with the body pool of Ca." (Excerpta Med. 8: 4915.)

1087. HURSH, J. B. The mechanism by which BAL lengthens survival of rats after lethal doses of polonium. U.S. Atomic Energy Comm. ANL-5584, p. 94-99. 1956.

"BAL promotes the early excretion of Po so that the 10-day elimination is raised from approx. 25 to 50% of the dose. The presence of BAL in some way maintains a larger fraction of the plasma Po in a membrane permeable state. A second way in which BAL lengthens survival is by a redistribution of the unexcreted Po remaining in the body." (Chem. Abs. 51: 4556.)

1088. JOWSEY, J. The chelation of skeletally deposited yttrium by ethylenediaminetetraacetic acid (EDTA). U.S. Atomic Energy Comm. ANL-5584, p. 130. 1956.

"It was found that EDTA removes Y most extensively from the metaphyseal trabeculae. Detailed studies on the deposition of Y in bone have shown that the region of the trabeculae is an area where new bone is not laid down extensively and the sites of deposition are not covered by new bone. Other areas of deposition in the shaft and endosteal metaphysis become buried by new bone and are unavailable for chelation. Repeated injections of EDTA also reduce the skeletal burden by chelating with the Y released into the blood stream by resorption of areas of primary deposition." (Chem. Abs. 51: 4557.)

1089. KAWIN, B. Effects of carrier upon distribution of Ca^{45} and Sr^{90} in rats. U.S. Atomic Energy Comm. HW-41500, p. 14-18. 1956.

"Intraperitoneal administration of stable strontium in amounts up to 11.2 mg. per 100 g. body weight decreased the fraction of simultaneously administered Sr^{90} deposited in the femurs of rats by no more than one-third. No effects upon Sr^{90} or Ca^{45} bone uptake resulted from simultaneous administration of similar quantities of stable calcium." (Author's summary.)

1090. KIKUCHI, T., and others. The metabolism of fission products. IV. The effects of EDTA-Na (Na ethylenediaminetetraacetate) upon the metabolism of radiostrontium and radioyttrium in mice. Kyoto Univ. Inst. Chem. Res. Bul. (sup. issue), Nov. 1954, p. 106-111. 1954.

G. Wakisaka, T. Kono, H. Akagi, T. Yamamasu, and I. Sugawa, joint authors.

"The toxicity of EDTA-Na , inert $\text{Sr}(\text{NO}_3)_2$ and $\text{Ba}(\text{NO}_3)_2$ has been examined. Simultaneous injection of EDTA-Na showed no significant effect upon the distribution of radio- Sr in the bones of mice. The distribution of radio- Y in the bones of mice tended to decrease following the simultaneous subcutaneous injection of Y^{91} and EDTA-Na ." (Chem. Abs. 49: 5138.)

1091. KISIELESKI, W. E., NORRIS, W. P., and WOODRUFF, L. A. The effect of BAL on distribution and metabolism of P^{32} and Sr^{90} . Soc. Expt. Biol. and Med. Proc. 77: 694-696. 1951.

"In mice, BAL had no significant effect on the distribution and elimination of the injected radioactive substances." (Chem. Abs. 45: 10385.)

1092. KISIELESKI, W. E., NORRIS, W. P., and WOODRUFF, L. A. Effect of BAL on distribution and metabolism of phosphorus-32 and strontium-90. U.S. Atomic Energy Comm. ANL-5584, p. 91-93. 1956.

" C_3H male mice between 5 and 6 months of age were studied to det. the effect of administration of BAL on the retention and distribution of P^{32} and Sr^{90} . BAL had no effect on the retention of P^{32} and Sr^{90} . It had no effect on either the rate of uptake, distribution, or total retention of Sr^{90} . Therefore, BAL cannot be used as an agent to accelerate elimination of P^{32} or Sr^{90} ." (Chem. Abs. 51: 4556.)

1093. KORNBERG, H. A. Effectiveness of isotopic dilution. U.S. Atomic Energy Comm. HW-41500, p. 19-28. 1956.

"Four processes that govern the transfer and deposition of substances, namely flow, diffusion, adsorption, and chemical reaction, are analyzed for the possibility of decreasing the uptake and deposition of a radioelement by its nonradioactive isotope. Effective isotopic dilution occurs when saturation of an acceptor substance is approached, and that is possible only in the process of adsorption or chemical reaction." (Author's summary.)

1094. KROLL, H. Development of chelating agents potentially more effective than ethylenediaminetetraacetic acid in radioelement removal. U.S. Atomic Energy Comm. ANL-5584, p. 150-151. 1956.

"The chelating agent, $\text{N,N,N',N'-tetracarboxymethyl di-(2-aminoethyl) ether (I)}$, has a soly. in dil. acids of approx. 10%. The chelating tendency of I for heavy metals is of the same order as ethylenediaminetetraacetic acid (EDTA). Another chelating agent, Chel 124, binds Ca at pH 7 and higher, and shows a max. affinity for this ion at about pH 8. At pH 7 to 7.5 Chel 124 will preferentially bind heavy metal ions much more avidly than Ca ." (Chem. Abs. 51: 4557.)

1095. LASZLO, D., and SPENCER, H. The interrelationship of calcium, strontium and metal metabolism and the effect of chelating agents thereon. U.S. Atomic Energy Comm. ANL-5584, p. 53-68. 1956.

1096. LEWIN, S. Planned restriction of radioactive uptake by animals. Brit. Vet. Jour. 113: 380-385. 1957.

"The theoretical aspects of methods for reducing intake of Sr^{90} by animals are considered. It is suggested that, because of its similarity to calcification of bone in mammals, formation of egg shell in poultry is likely to be a fruitful field of study." (Nutr. Abs. and Rev. 28: 851.)

1097. LINDENBAUM, A., ROSENTHAL, M. W., and FRIED, J. F. Progress report: Radiostrontium removal. U.S. Atomic Energy Comm. ANL-5732, p. 134-136. 1957.

1098. LINDENBAUM, A., SCHUBERT, J., and FRIED, J. F. Treatment of radiostrontium poisoning. Amer. Chem. Soc. Abs. Apr. 13-18, 1958: 18M. 1958.

The removal of radiostrontium from the body is difficult because of its close resemblance to calcium and consequent rapid sequestration in bone. Chelating agents such as the polyamino acids, e.g., ethylenediaminetetraacetic acid, are of limited effectiveness, because they invariably bind calcium more strongly than strontium. Because of the low therapeutic effectiveness of chelating agents and of other hitherto used measures, two other types of chemical agents are being investigated: Substances capable of preferentially forming insoluble compounds with strontium in the presence of calcium under physiological conditions and compounds that bind cations by ion exchange and hence would be expected to bind strontium more strongly than calcium in the physiological range of salt concentrations. One group of selective precipitating agents for strontium is represented by the analytical reagents, rhodizonic acid and tetrahydroxyquinone. The sodium of potassium salts of these substances preferentially precipitate strontium and barium, in the presence of calcium, from neutral solutions. Strontium added to blood serum was similarly precipitated. Although the rhodizonate analogs presumably bind metals through the mechanism of chelation and lake formation, preliminary binding studies indicate the possibility of a surface or ion-exchange effect in addition. Salts of both analogs are tasteless, yellow-orange dyes, which are rapidly excreted and have low toxicity when aqueous solutions are given orally, intravenously, or intraperitoneally. Potassium and sodium rhodizonate are equally effective, when given orally or intraperitoneally, in promoting increased excretion of intravenously administered strontium 85. The body burden of strontium was reduced by approximately 20 percent after 24 hours. When strontium 85 was given orally, the reduction in body burden after 24 hours amounted to 34 percent. In each case the reduction was mainly the result of a decreased strontium 85 concentration in the bones. Additional means of promoting increased excretion of radiostrontium, such as incorporation of rhodizonates in the diet or by the use of diuretics, are discussed. Other possible mechanisms for the promotion of radiostrontium removal are considered.

1099. LOONEY, W. B., MALETSKOS, C. J., and HELMICK, M. J. The removal of radiocalcium from dogs. U.S. Atomic Energy Comm. AECU-3261, p. 35-43. 1956.

1100. LOONEY, W. B., and others. The artificial kidney and ion-exchange resins as possible methods of removing radioelements from the body. Radiology 68: 255-256. 1957.

C. J. Maletskos, M. J. Helmick, J. Reardon, J. Cohen, and W. Guild, joint authors.

The removal of Ca^{45} , Sr^{85} , or Sr^{90} was attempted from dogs at 1 hour, 3 days, and 7 days after intravenous injection. At 1 hour after injection, 30-41 percent of the injected dose of these radionuclides was removed by either the artificial kidney or ion-exchange column. At 3 and 7 days, 1.9 and less than 1 percent were removed, respectively. The duration of the removal time for these experiments ranged from 3 to 7 hours.

1101. MacDONALD, N. S. Diminishing the skeletal retention of ingested radiostrontium by use of chemical

agents. Therapy of radioelement poisoning. U.S. Atomic Energy Comm. ANL-5584, p. 83. 1956.

Discussion of possible methods for reducing radiostrontium retention.

1102. MARIANI, B., and BISETTI, A. Increase of the calcium content of the blood after administration of the calcium salt of ethylenediaminetetraacetic acid. *Ann. dell' Ist. "Carlo Forlanini"* 15: 40-46. 1955.

"Intravenous administration in a single dose causes, after a few hrs., an elevation of the Ca content of the blood only when at least 2.5 g. is used. The administration of 2 g. a day, in 2 injections of 1 g. each, shows remarkable increase of the Ca content from the 2nd to the 5th day. The same results can be obtained by using 2 suppositories. In cases with high Ca content of the blood, a sudden drop occurs after a few days." (Chem. Abs. 50: 2042.)

1103. MAYR, F., and others. The effects of a complex magnesium preparation, disodium salt of magnesium-ethylene diamine tetraacetic acid on the blood calcium level and the calcium excretion in the urine. *Wien. Med. Wchnschr.* 104: 993-995. 1954.

A. Holasek, H. Flaschka, and N. Geyer, joint authors. "After intravenous injection of 100 mg. of this compd., blood pressure fell. This effect is brought about by substitution of Mg by Ca when the compd. is injected into the blood, so that its action is that of free Mg, the effect of which is still enhanced because the antagonistic Ca is bound." (Chem. Abs. 50: 14101.)

1104. MICHON, G., and JEANMAIRE, L. Use of ion-exchange resins for internal contamination by radioactive elements. *Acad. des Sci. Paris, Compt. Rend.* 244: 396-398. 1957.

"Studies with Sr^{90} and different ion-exchange resins show that the oral administration of the resin, following ingestion of the Sr^{90} , holds part of it in the digestive tract and decreases to a similar extent fixation in the crit. organs." (Chem. Abs. 51: 8987.)

1105. NERVIK, W. E., KALKSTEIN, M. I., and LIBBY, W. F. Purification of milk for calcium and strontium with Dowex-50 W. resin. U.S. Atomic Energy Comm. UCRL-2674, 13 p. 1954.

"It appears from the cursory data obtained in this preliminary test of the possibility of purifying milk by ion-exchange resin that both calcium and strontium are relatively completely removed in either a bulk treatment or the more standard column treatment. The data on the bulk treatment indicate that at least 90 percent of the calcium is removed, and similar conclusions are to be drawn from the column data." (Author's summary.)

1106. NESBITT, J. B., and others. Removal of radioactive strontium from water by phosphate coagulation. U.S. Atomic Energy Comm. NYO-4435, 128 p. 1952.

W. J. Kaufman, R. F. McCauley, and R. Eliassen, joint authors.

"In a study of methods for the decontamination of public water supplies containing radioactive cationic contaminants, the removal characteristics of Sr^{90} were investigated. Previous work on the removal of radioactive substances from water is reviewed. The fundamental mechanisms of the phosphate coagulation process in the removal of cationic contaminants from water and the basic concepts of colloid chemistry relating to absorption, coprecipitation, and flocculation are summarized. Experimental data are presented on the removal of Sr^{90} by phosphate coagulation and the removal of excess phosphate from phosphate-process effluent. Data are included from pilot-plant studies on the effect of rapid sand filtration in the removal of Sr from the phosphate-process effluent and the mechanisms by which removal is accomplished. It was concluded that a phosphate coagulation process is effective in the removal of Sr at a pH near 10.2 with excess phosphate, but that with the excessive phosphate doses required the process is not economically feasible at the present time." (Nuclear Sci. Abs. 6: 6576.)

1107. ROSENTHAL, M. W., ed. Therapy of radioelement poisoning. Transcription of a meeting on experimental and chemical approaches to the treatment of poisoning by radioactive substances. U.S. Atomic Energy Comm. ANL-5584, 175 p. 1956.

1108. ROSENTHAL, M. W. The use of zirconium and other carriers in the removal of radioelements from the body. The use of complexing agents. U.S. Atomic Energy Comm. ANL-5584, p. 100-113. 1956.

"The effect of the carrier is primarily on the circulating radioelement; i.e., bone deposition is reduced by the excretion of the blood radioelement rather than withdrawal of radioelement already deposited in the bone. Therefore, treatment should be instituted as soon as possible, after contamination. With disappearance of the radioelement from the blood, there is little hope of achieving any significant reduction in body burden without prolonged treatment, and exptl. evidence of the value of this had not yet been obtained. If pretreatment is to be used it is important to have a max. amt. of carrier in the blood at the time of possible radioelement contamination. In post-treatment, at least a min. dose should be used to achieve max. bone reduction. Increasing the dose does not increase the effect on the bone, but does cause increased radioelement excretion and loss from the liver and other soft tissues. Therefore, excretion of radioelement is not a measure of degree of reduction in bone content. The expts. using a series of metal carriers not only strengthen the basic theory behind the carrier concept but emphasize the importance of preliminary exptl. work to select a suitable carrier that will have the desired effects—removal of radioelement from the blood with subsequent excretion." (Chem. Abs. 51: 4556.)

1109. RUBIN, M., and LINDENBLAD, G. E. Chelating agents in the study of renal absorption of alkaline earth cations. *N.Y. Acad. Sci. Ann.* 64: 337-342. 1956.

"Rats were made acutely hypocalcemic by the intraperitoneal injection of ethylenediaminetetraacetate acid (I). When Ca ethylenediaminetetraacetate (II) was administered simultaneously, urinary excretion of $\text{Ca}^{++} + \text{Mg}^{++}$ decreased from about 75% of the simultaneous urinary I to a min. concn. of approx. 33%. When rats were pretreated with a carbonic anhydrase inhibitor (Diamox) followed by I and II, resorption of Ca from II was not present despite the acute hypocalcemia. Similar results were obtained with NaHCO_3 alkalosis. In both instances the alk. kidney tubule inhibited resorption of Ca from II. Acidosis produced by oral administration of NH_4Cl gave results suggesting an increased retention of Ca. The authors conclude (1) in the areas of the tubule at which the H^+ -alk. metal exchange mechanisms of resorption occur are also areas where alk. earths may be reabsorbed; (2) acute hypocalcemia enhances activity of the renal carbonic anhydrase base-exchange mechanism." (Chem. Abs. 51: 9002.)

1110. SCHUBERT, J. Approaches to treatment of poisoning by both radioactive and non-radioactive elements encountered in atomic energy operations. *Internatl. Conf. Peaceful Uses Atomic Energy, Geneva, 1955, A/CONF. 8/P/845 USA*, 56 p. 1955.

A discussion of similarities and differences in approach inherent in the treatment of nonradioactive metal and radioactive metal poisonings, the potential advantages and disadvantages of different treatments, and new or untried possibilities for treatment.

1111. SCHUBERT, J. Removal of radioelements from the mammalian body. *Ann. Rev. Nuclear Sci.* 5: 369-412. 1955.

1112. SHAW, J. H., and GUPTA, O. P. Relation of a chelating agent to smooth-surface lesions in the white rat. *Jour. Nutr.* 60: 311-322. 1956.

"0.2% of 0.4% EDTA fed with a cariogenic diet produced smooth-surface lesions, grossly resembling simple

decalcification, on rat's molar teeth. Lesions were proportional to the concn. of chelating agent given. EDTA given with a non-cariogenic diet caused no lesions. Desalivation of the rats intensified the influence of EDTA but EDTA given by stomach tube caused little decalcification with the cariogenic diet. Caries-resistant rats were less affected by the EDTA gel. The lesions observed seemed identical with smooth-surface caries rather than those resulting from simple decalcification by chelating agents." (*Internatl. Abs. Biol. Sci.* 7: 589.)

1113. SPENCER, H., and others. The effect of ethylenediaminetetraacetic acid in hypercalcemia. *Jour. Lab. and Clin. Med.* 47: 29-41. 1956.
J. Greenberg, E. Berger, M. Perrone, and D. Laszlo, joint authors.

"The chelating agent Na ethylenediaminetetraacetate (I) was administered intravenously to 8 hypercalcemic patients in a dose of 4 g. In each of these patients the serum Ca was temporarily lowered as the excess Ca was chelated. The Ca chelated was excreted by the kidneys. In normocalcemic subjects the chelation of the serum Ca was promptly followed by release of Ca from body stores to maintain the ionized Ca at normal levels. The total calcium increases because of this influx of Ca into the circulation and returns to normal levels as the Ca chelate is excreted. The excess urinary Ca reflects the magnitude of the Ca influx. The amt. of lowering of the serum Ca was predictable by using the stoichiometric relationship that 1 g. I binds 0.108 g. of Ca and therefore the amt. of I injected was such as to bind the excess Ca estd. to be in the extracellular space. Methods of analysis for ionized (nonchelated) Ca and total Ca are given." (*Chem. Abs.* 50: 9605.)

1114. SPENCER, H., and others. Factors modifying radiostrontium excretion in man. *Fed. Proc.* 16: 122. 1957.

J. Samachson, B. Kabakow, and D. Laszlo, joint authors.
"In studying the calcium and radiostrontium metabolism in patients with metabolic and malignant bone diseases, a correlation was noted between renal clearances of calcium and radiostrontium. In order to investigate this relationship further, the effect of sudden elevation or of lowering of the ionized plasma calcium upon the renal clearance of calcium and strontium was studied. The elevation of ionized serum calcium was achieved by the slow i.v. infusion of approximately 500 mg. Ca^{++} as the gluconate. Marked enhancement of radiostrontium and of calcium clearances was noted. When the ionized plasma calcium was depressed by the infusion of Na-EDTA, a significant decrease of radiostrontium and of ionized calcium excretion was observed. It was previously reported by Charles that the administration of ammonium chloride markedly enhances the urinary calcium and radiostrontium excretion and thereby significantly reduces the radiostrontium body burden. The mechanism of this action was assumed to be due to induced metabolic acidosis, causing decreased tubular reabsorption of calcium and strontium, decalcification, and decreased deposition of radiostrontium on the bone surfaces. In order to test whether the combination of oral ammonium chloride and of calcium infusions would be more effective than either agent alone, metabolic studies were carried out in four phases: Control (Sr^{85} i.v.), intravenous calcium gluconate, oral NH_4Cl , and the combination of oral NH_4Cl and intravenous calcium gluconate. Representative data are shown to illustrate that the combination of the two agents was superior in decreasing the radiostrontium body burden." (Author's abstract.)

1121. AL'BITSKIĬ, B. A. Study of calcium metabolism by means of labeled atoms. *Tomsk Univ., Tomsk Med. Inst.* 5-yĭ Pavlosk Sborn. 1956: 77-80. 1956.

"A description is given of a Ca^{45} method for the study of decalcification of kidney tissue following vascular ligation. Detn. of radioactive impulses in microsections of the same size indicated an increasing radioactivity of the

1115. SPENCER, H., SAMACHSON, J., and LASZLO, D. Effect of ethylenediaminetetraacetic acid on radiostrontium excretion in man. *Soc. Expt. Biol. and Med. Proc.* 97: 565-567. 1958.

"The effect of sodium salt of ethylenediaminetetraacetic acid, Na-EDTA, upon radiostrontium (Sr^{85}) metabolism in man was investigated under controlled metabolic conditions. Urinary radiostrontium excretion was inhibited in each of three patients when Na-EDTA was infused. This depression was followed by excess excretion of the isotope after discontinuation of Na-EDTA. The mechanism of action responsible for this metabolic shift is discussed." (Author's summary.)

1116. SPENCER, H., and others. Removal of calcium in man by ethylenediaminetetraacetic acid. A metabolic study. *Jour. Clin. Invest.* 31: 1023-1027. 1952.

V. Vankinscott, I. Lewin, and D. Laszlo, joint authors.
"Slow intravenous infusion of EDT induced excess calcinuria without lowering the serum Ca levels. This indicates prompt replenishment of the complexed serum Ca by ionized Ca mobilized from the skeletal depots. The Ca salt of EDT is rapidly excreted through the kidneys." (*Chem. Abs.* 47: 2367.)

1117. TALMAGE, R. V., SCHOOLEY, J. C., and COMAR, C. L. Differential removal of strontium-85 and calcium-45 from rat skeleton by peritoneal lavage. *Soc. Expt. Biol. and Med. Proc.* 95: 413-417. 1957.

"Each rat received an intraperitoneal injection of a soln. contg. about 0.05 mc. of Ca^{45} and 0.005 mc. of Sr^{85} , both essentially carrier-free. After 24 hrs. peritoneal lavage was begun by a modification of the method of Talmage and Elliot (*C.A.* 50, 17064d). From comparisons of Sr/Ca ratios in lavage solns. and bones of nephrectomized rats it is estd. that Sr was preferentially released from bone by a factor of 1.3 over Ca. It was calcd. that Sr preferentially entered bone from blood by a factor of 1.3-1.6. In intact rats the differential removal of Sr and Ca was shown to be due mainly to renal function. Eight hrs. of peritoneal lavage removed about 5% of the Sr^{85} that had been deposited in bone if begun 24 hrs. after the injection, but only about 0.6% if delayed until 8 days after the injection." (*Chem. Abs.* 51: 14977.)

1118. THOMPSON, R. Research at Hanford on therapy for internally deposited plutonium. *U.S. Atomic Energy Comm. ANL-5584*, p. 114-122. 1956.

"In the dog, as in the rat, zirconium citrate is more effective than calcium ethylenediaminetetraacetate in reducing bone deposition and also in increasing urinary excretion of plutonium." (*Chem. Abs.* 51: 4556.)

1119. TODDE, I. Decalcifying drugs and mobilization of calcium. *Atti dell' Accad. dei Fisiocritici Siena, Sez. Med.-Fis. I*: 198-203. 1954.

1120. VAUGHAN, J. M., and TUTT, M. L. Use of ethylenediaminetetraacetic acid (Versene) for removing fission products from the skeleton. *Lancet* 265: 856-859. 1953.

"Ca disodium and trisodium ethylenediaminetetraacetic acid appeared to increase the excretion of Y^{91} and Y^{90} when given shortly after the administration of the isotope. There was no effect on Sr^{90} . The effect on Y excretion was greater in young than in old animals. All animals receiving Versene had adhesions and some inflammation of the abdominal wall." (*Chem. Abs.* 49: 515.)

ANALYTICAL METHODS

kidney tissue resulting from the accumulation of Ca^{45} ." (*Chem. Abs.* 52: 6539.)

1122. BACKMANN, R., and HARBERS, E. Determination of specific activity of inorganic phosphorus in tissues in studies with radioactive phosphorus. *Naturwissenschaften* 41: 64-65. 1954.

"The usual precipitation reactions are often unsatisfactory for the isolation of inorganic phosphate with a view to activity determination with the counter tube, as up to 20% of absorbed organic phosphate (chiefly labile ATP) may be carried down with the precipitate. This difficulty can be avoided by isolating the inorganic phosphate by paper chromatography (Hanes and Isherwood, *Nature*, 1952, 170-800), while the chemical phosphate analysis can be carried out directly (without isolation) by the colorimetric method of Gomori (*J. Lab. Clin. Med.*, 1941, 27, 955). The above method is precise and is applicable to small amounts of tissue provided the amount of activity is sufficient for satisfactory counter measurements." (*Excerpta Med.* 8: 1311.)

1123. BALLCZO, H., and MUTHENTHALER, H. Enrichment and microtitrimetric determination of the strontium cation in mineral waters. *Mikrochem. Ver. Mikrochim. Acta* 39: 152-165. 1952.

"By passing enough of the water to contain about 500 γ of Sr through a column of Al_2O_3 which has been treated with NaOH soln., all of the Sr and Ba can be adsorbed by the column while the Ca passes through. The Ba and Sr can be easily removed from the column by washing with N HNO₃. From this HNO₃ soln. it is then necessary to remove SiO₂ by evap. with HNO₃, dehydrating, taking up in HNO₃ and then filtering. Dissolved Al_2O_3 can be removed by pptn. with NH_4OH . By fusion of the residue obtained by evap. the filtrate to dryness with 30 times as much H_3BO_3 , the $\text{Sr}(\text{NO}_3)_2$ is converted to borate and this can be dissolved in a carefully measured vol. of 0.01 N HCl (about 2 ml.). Then, by dilg. and adding MeOH, about 40% of the H_3BO_3 can be removed by volatilization of the methyl ester. Finally the excess HCl added can be detd. by the principle of double titration with 0.0002 N Na borate in the presence of a mixt. of methyl red and methylene blue indicators. Numerous precautions are necessary. In a mineral water tested, 1000 g. of sample contained 0.564 mg. of Sr, 100 mg. of Ca, 78 mg. of H_2SiO_3 , 10 mg. of HPO_4^{2-} , 192 mg. of SO_4^{--} , and 20 mg. of H_3BO_3 . These values are probably within less than 4% of the truth." (*Chem. Abs.* 46: 6550.)

1124. BAUER, G. C. H. A rapid method for the simultaneous determination of calcium and sodium in bone. *Acta Physiol. Scand.* 31: 351-358. 1954.

"The concn. of Ca in the unknown is detd. by flame photometry. The concn. of Na in the unknown is also detd. by flame photometry with a synthetic bone soln. as a standard. Ca is read on a DU Beckmann spectrophotometer at 4227 Å. and Na at 5890 Å. Synthetic mineral solns. are prepd. by dissolving $\text{Ca}_3(\text{PO}_4)_2$ in less than 1% CCl_3COOH and NaCl in H_2O , Na does not appreciably interfere with the Ca readings provided the wt. ratio Ca/Na does not exceed 11/1. The Ca readings are linearly related within a wide range of Ca concns. Doubling the concn. of Ca depresses the Na readings about 4% when the Na is read with the blue-sensitive phototube. When the Ca concn. is kept const., the Na readings are linearly related within a wide range of Na concns." (*Chem. Abs.* 49: 1134.)

1125. BROOKSBANK, W. A., LEDDICOTTE, G. W., and MAHLMAN, H. A. Analysis for trace impurities by neutron activation. *Jour. Phys. Chem.* 57: 815-819. 1953.

"The techniques of the method of neutron radioactivation analysis and the sensitivities of detection of several elements in a variety of materials are discussed. Methods for the analysis of V in crude oil, Mn in alloys, Cd in resins, Sr in animal tissue, Ga in Al, and Co in crude biol. materials are described." (*Chem. Abs.* 48: 1195.)

1126. BRYANT, F. J., and others. Radiostrontium fallout in biological materials in Britain. *Atomic Energy Res. Estab. (Gt. Brit.) HP/R 2056*, 46 p. 1957.

A. C. Chamberlain, A. Morgan, and G. S. Spicer, joint authors.

"Minor modifications are described in the exptl. pro-

cedure used in a previous report in which fallout of Sr^{90} was detd. in vegetation, bones, and milk up to 1956. No significant change was made in the general conclusion that current levels are approx. equal in U.S.A. and Great Britain. Children under age 3 show about 5 times the Sr^{90} activity in the bones as persons over 50." (*Chem. Abs.* 51: 16120.)

1127. CARR, M. H., and FRANK, H. A., Improved method for determination of calcium and magnesium in biological fluids by ethylenediaminetetraacetate titration. *Amer. Jour. Clin. Path.* 26: 1157-1168. 1956.

"Ca is sepd. from Mg by pptn. as the oxalate. It is then washed, redissolved, and titrated with disodium ethylenediaminetetraacetate (EDTA). Eriochrome Black T is used as the indicator. Mg is titrated with the same reagents in an aliquot of the supernatant fluid. The procedure is simple and easy to perform, and yields results of high accuracy." (*Chem. Abs.* 51: 2927.)

1128. CHEN, P. S., JR., and TORIBARA, T. Y. Determination of calcium in biological material by flame photometry. *Analyt. Chem.* 25: 1642-1644. 1953.

"A study of the interference problems. Ca can be detd. in blood serum (I), serum ultrafiltrate (II), and urine (III) by comparison with a suitable standard in a flame photometer at 620 m μ . Because the proteins in I eliminated the quenching effect produced by the usual concns. of phosphate, I can be used directly (with attention to Na effects). In II, correction for phosphate quenching is necessary; in III preliminary isolation of Ca as the oxalate is recommended. Oxalate, sulfate, NH_4^+ , and bicarbonate do not interfere; nor does Mg coming down with the Ca oxalate. If only a small sample of III is available, or if Na and K, as well as Ca, are to be detd.; acidified, dild. III is used directly in the flame photometer. In routine work the method is accurate to within $\pm 3-4\%$." (*Chem. Abs.* 48: 2804.)

1129. CHOW, T. J., and THOMPSON, T. G. Flame photometric determination of strontium in sea water. *Analyt. Chem.* 27: 18-21. 1955.

"Sr has been detd. in several sea-water samples from the Atlantic, Pacific, and Arctic Oceans. The Sr line at 460.7 m μ was employed. The flame background at 454 m μ is equal to that at 460.7 m μ ; thus the difference between readings at these 2 wave lengths is used as a measure of the intensity of the Sr line. Of the ions present in sea water only Ca^{++} interferes by overlapping the Sr emission at 460.7 m μ with a slit width of 0.02 mm. Mg^{++} , SO_4^{--} , Cl^- , Na^+ , Ca^{++} and K^+ affect the excitation of the Sr line. These difficulties can be circumvented by adding equal aliquots of the sea-water sample to a series of standard solns. in which the Sr concn. is varied and extrapolating to obtain the reading for a soln. in which the only Sr present is that in the sea water. The data show that Sr occurs in sea water in const. proportion to the chlorinity; the Sr-chlorinity ratio is 0.0048 ± 0.0002 ." (*Chem. Abs.* 49: 5204.)

1130. DENSON, J. R. Flame photometric determination of electrolytes in tissue and of calcium in serum. *Jour. Biol. Chem.* 209: 233-240. 1954.

"A flame spectrophotometric method was developed for the simultaneous detn. of Ca, Mg, Na, and K in tissue. A rapid method for the detn. of Ca in blood was also worked out. The values obtained by the flame method for Ca and Mg are comparable with those obtained by chem. methods. The recovery values for all 4 cations are satisfactory." (*Chem. Abs.* 48: 10826.)

1131. ELVING, P. J., and VAN ATTA, R. E. Precipitation in homogeneous solution. Separation and determination of barium, strontium, and calcium. *Analyt. Chem.* 22: 1375-1378. 1950.

"Ba, Sr, and Ca can be sepd. quantitatively as readily filterable SO_4 ppts. by digestion of an aq. MeOH soln. contg. Me_2SO_4 . Hydrolysis of the latter furnishes the pptg. SO_4 ion. Procedure for Ba: Add 20 ml. of MeOH

to a soln. of 1 to 100 mg. of Ba preferably present as chloride or nitrate. Dil. to 95 to 98 ml. Add 0.5 ml. of Me_2SO_4 per 10 mg. of Ba (2 ml./min.). Digest on steam bath for 75 min., adding MeOH if necessary to restore the 100-ml. vol. Filter through a weighed porcelain filtering crucible and wash with 20% MeOH. Dry at 100°–150° and heat for 30–60 min. at 750°. Small amts. of Sr interfere, but large amts. of Ca, Al, Fe, and NH_4 and moderate amts. of Na, K, and Mg do not. Ba can be detd. precisely in mixts. approximating the compn. of barytes samples, Sr and Ca can be pptd. by modified procedures in higher concns. of MeOH." (Chem. Abs. 45: 1461.)

1132. ENGSTROM, A., LAGERGREN, C., and LUNDBERG, B. Determination of strontium and calcium in bone by X-ray absorptiometry. Expt. Cell Res. 12: 592–598. 1957.

1133. FARABEE, L. B. Procedure for radiochemical analysis of strontium and barium in human urine (with bibliography). U.S. Atomic Energy Comm. ORNL-1932, 22 p. 1955.

1134. HAHN, R. B. Separation of calcium and strontium in semimicro qualitative analysis. Jour. Chem. Ed. 30: 349. 1953.

"After usual elimination of Ba in Group IV, the ppt. of CaCO_3 and SrCO_3 is dissolved in 72% HNO_3 , the mixt. is allowed to stand for 10 min., then centrifuged, and the supernatant liquid is decanted into 20 ml. of H_2O . This soln. is used for the CaC_2O_4 confirmatory test for Ca. The ppt. is stirred with 1 ml. of 72% HNO_3 and centrifuged. The $\text{Sr}(\text{NO}_3)_2$ ppt. is dissolved in 3 ml. of hot H_2O and the presence of Sr is confirmed by the flame test or by pptn. as SrSO_4 . As little as 1 mg. of Ca or Sr can be detected in the presence of 50 mg. of the other." (Chem. Abs. 47: 11070.)

1135. HARRISON, G. E., and RAYMOND, W. H. A. The estimation of trace amounts of barium or strontium in biological material by activation analysis. Jour. Nuclear Energy 1: 290–298. 1955.

"Samples and standards are irradiated for 2 hrs. at 2×10^{12} neutrons/sq. cm./sec. and the induced 1.4-hr. Ba^{139} and 2.7-hr. Sr^{87m} activities are compared at various times after cooling and sepn. with a γ -scintillation counter. Samples for irradiation are dry-ashed at 600° (for urine, the pptd. oxalates are ashed), the ash taken up in 19N HNO_3 , trivalent activities scavenged therefrom by Fe, and Ba and Sr are sepd. by chromate pptn. Ca does not interfere; 1–50 γ of either Ba or Sr is detd. with an error of 5%." (Chem. Abs. 49: 12571.)

1136. HARRISON, G. E., RAYMOND, W. H. A., and SUTTON, A. Estimation of radioactive strontium in the excreta. Clin. Sci. 13: 61–67. 1954.

"A simple method is described for the estn. of Sr^{90} in urine and feces. The 24-hr. urine collected over a few ml. concd. HCl is treated with 5 g. solid $(\text{NH}_4)_2\text{C}_2\text{O}_4$, the pH brought to between 5 and 6, warmed to coagulate the pptd. oxalates, and chilled 24 hrs. The ppt. is collected by centrifugation at 1000 g, dissolved in a few ml. warm 6N HNO_3 , dild. to 25 ml. with water, and measured with a shielded alc.-filled Geiger-Müller counter. Feces are ashed at 700°, dissolved in warm 6N HNO_3 , cooled, centrifuged, and the supernatant treated as described. A chem. sepn. from Ca is described." (Chem. Abs. 49: 7032.)

1137. HUDITZ, F., FLASCHKA, H., and PETZOLD, I. Precipitation of the phosphate ion with magnesium (ions) in the presence of calcium and other cations, as well as its analytical determination with ethylenediaminetetraacetic acid. Ztschr. f. Analyt. Chem. 135: 333–340. 1952.

"Ethylenediaminetetraacetic acid (Complexon II; its Na salt is Complexon III) can be used to prevent the formation of many hydroxides upon the addn. of NH_4OH

or NaOH, and also as a titrant for Mg^{2+} . Thus to an acid soln. contg. Mg^{2+} and other cations, add enough M or 2 M Complexon II soln. to prevent pptn. by NH_4OH and then ppt. the PO_4^{3-} as $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$ in the usual manner. Dissolve the washed ppt. in 5 ml. of N HCl, add 10 ml. of 3 N NH_4OH , and det. the Mg content of this soln. by titration with a standard soln. of Complexon II. Many excellent results are given in titrating 1–6 mg. of P. Other masking agents, such as citric acid, can be used before pptg. PO_4^{3-} in solns. contg. Ca, Mg, Ba, Sr, Ni, Cu, Zn, Cd, Pb, etc. AsO_4^{3-} behaves like PO_4^{3-} in the above procedure." (Chem. Abs. 46: 6550.)

1138. JENNESS, R. Titration of calcium and magnesium in milk and milk fractions with ethylenediaminetetraacetate. Jour. Analyt. Chem. 25: 966–968. 1953.

"Ca and Mg in milk cannot be titrated with ethylenediaminetetraacetate and suitable indicators unless the interference from orthophosphate is eliminated. An anion-exchange column with Duolite A-4 will quantitatively remove phosphate and is equally effective whether the milk samples have been prepd. by dry ashing, wet digestion, or acid pptn. of the casein. Applicability of the technique to plant tissue analysis is suggested." (Chem. Abs. 47: 8921.)

1139. KIBRICK, A. C., PALMER, D., and SKUPP, S. A method for the colorimetric determination of calcium in 0.5 ml. of serum. Soc. Expt. Biol. and Med. Proc. 76: 115–116. 1951.

"The Ca is pptd. as oxalate, the washed ppt. is dissolved in 1 ml. of N H_2SO_4 , 4 ml. of a Ce sulfate reagent soln. is added, and the change in color is measured in an Evelyn colorimeter. Details are given. The results agree closely with those obtained by the KMnO_4 titration method." (Chem. Abs. 45: 3893.)

1140. KINGSLEY, G. R., and SCHAFFERT, R. R. Direct microdetermination of sodium, potassium, and calcium. Analyt. Chem. 25: 1738–1741. 1953.

"The use of the photo-multiplier tube attachment with the Beckman DU flame photometer permitted the selection of narrow slit widths of light, and the elimination of nonspecific spectral emission. Excellent measurement and recovery were obtained in serum and urine detns. in the presence of extreme ratios of Na, K, Ca, cholesterol, P, glucose, and urea." (Chem. Abs. 48: 2805.)

1141. KISIELESKI, W. E. The analysis of mixtures of Sr^{89} and Sr^{90} . U.S. Atomic Energy Comm. ANL-5288, p. 76–78. 1954.

1142. LUICK, J. R., and LOFGREEN, G. P. An improved method for the determination of metabolic fecal phosphorus. Jour. Anim. Sci. 16: 201–206. 1957.

"Four yearling lambs were used in tracer trials in a method for the detn. of metabolic fecal P. The method utilizes radioactive P^{32} which is injected as the insol. salt, $\text{Ca}_3(\text{PO}_4)_2$. Metabolic fecal P is calcd. by comparing the level of P^{32} in the feces to that in the plasma 24 hrs. earlier. Metabolic fecal P secretion varied from 0.76 to 2.5 g. per day and seemed to be positively correlated with total fecal P. Subcutaneous injection of labeled Ca phosphate gave a distinct advantage over both intraperitoneal Ca phosphate and intravenous Na phosphate." (Chem. Abs. 51: 13032.)

1143. McLEAN, F. C. Biologic method for estimation of calcium ion concentration. Methods in Med. Res. 4: 68–79. 1951.

An isolated frog heart preparation is used as a biological indicator of calcium ion concentration in solutions. The preparation is exposed to reference and unknown solutions; their effect on contraction is used as the indicator. The difficulties and limitations of this method are discussed and an evaluation is presented.

1144. MARTELL, E. A. The Chicago sunshine method. Absolute assay of strontium-90 in biological materials,

soils, waters, and air filters. U.S. Atomic Energy Comm. AECU-3262, 59 p. 1956.

"The analytical technique and counting method to determine the activity in a variety of biol. and inorg. materials are described." (Chem. Abs. 50: 15323.)

1145. MAWSON, C. A., and FISCHER, I. The estimation of radioactive strontium and other fission products in urine and water. Atomic Energy Proj. (Canada) CRM-455, 20 p. [n.d.]

"Methods are described for the estimation of small amounts of Sr^{90} and "mixed fission products" in urine and water. The active material is coprecipitated with calcium oxalate, and the washed oxalate is deposited on counting trays. Mean recoveries of about 87 percent of added Sr^{90} and fission products have been obtained from 750 ml. of urine and 2 liters of water. Various methods for the elimination of calcium from the material to be counted are discussed." (Author's summary.)

1146. MAYS, C. W., TAYSUM, D. H., and FISHER, W. Retention of Sr^{90} in dogs via bremsstrahlung counting. Utah Univ. Radiobiol. Lab. Ann. Prog. Rpt. AT (11-1): 119. 1958.

"Bremsstrahlung measurements were made on all the Sr^{90} injected dogs. In dogs strontium retention is slightly less than radium retention. Fractional retention is independent of the injected dose. A technique was developed with which low-level strontium burdens in 10 kg. dogs can be measured with a standard deviation of less than 0.1 $\mu\text{c.}$ of Sr^{90} ." (Author's abstract.)

1147. MOSHER, R. E., and others. The estimation of calcium in human plasma by flame spectrophotometry. Amer. Jour. Clin. Path. 21: 75-78. 1951.

M. Itano, A. J. Boyle, G. B. Myers, and L. T. Iseri, joint authors.

"Pipet 2.0 cc. of heparinized plasma into a 50-cc. beaker and add 6 cc. of a 3:1 $\text{HNO}_3\text{-HClO}_4$ mixt. Evap. on a hot plate to incipient dryness (fumes of HClO_4). Cool, add 2 drops of concd. HCl and 1 or 2 cc. of distd. water, and shake till dissolved. Transfer to a 15-cc. centrifuge tube. With 1 drop of methyl red indicator, neutralize with $(\text{NH}_4)_2\text{HPO}_4$ (1.3 g. in 250 cc. of distd. water), mix and place in hot water till coagulated. Centrifuge, decant, and drain 30 sec. on filter paper. Add 1 drop of concd. HCl , dil. to 10 cc. with NaCl (40 mg. per l.). Examine by flame spectrophotometer. The method is rapid and accurate." (Chem. Abs. 45: 2533.)

1148. NORMAN, N., BECK, J. C., and BROWNE, J. S. L. Separation of bone sodium, potassium, and calcium by the use of cation-exchange resin. Jour. Lab. and Clin. Med. 50: 308-312. 1957.

"A column is made of Dowex 50 12 mm. by 20 cm. The elution curve of the resin must be detn. for each batch. It is washed with 300 ml. of 3N HCl and then 200 ml. of water. A 0.2-g. fragment of bone is freed from tissue and marrow, dissolved in 1 ml. of concd. HNO_3 , dild. to 10 ml., and poured into the column reservoir. Normal HCl is the eluting agent. Na elutes first, and the recovery is 98-102% and that of K is 93-95%." (Chem. Abs. 52: 488.)

1149. NORRIS, W. P., and LAWRENCE, B. J. Determination of calcium in biological materials. A combined method for semimicrodetermination of Ca^{40} and radioassay of Ca^{45} . Analyt. Chem. 25: 956-960. 1953.

"Ca pptd. as the oxalate from biol. materials was mounted quant. on fritted glass by filtration in a manner adapted to radioactive counting as well as to subsequent detn. of total Ca. The low energy of the β -rays from Ca^{45} (E max.=0.254 m.e.v.) required that the sample be mounted uniformly and reproducibly, in order to correct for scattering and absorption of β -rays as a function of sample thickness. The early portion of the self-absorption curve is complicated by self-scattering. Quantities of Ca^{40} varied from 20 γ to 120 mg. with identical recoveries in all cases. Mean recoveries with assocd. standard

errors for Ca^{40} and Ca^{45} were 99.45 ± 0.13 and $98.54 \pm 0.28\%$, resp." (Chem. Abs. 47: 10042.)

1150. OSBORN, G. H. The rapid separation and determination of barium, strontium, and calcium in rocks and minerals. Miner. Mag. 27: 258-262. 1946.

1151. PHILLIPS, G., and JENKINS, E. N. Improved methods for the routine radiochemical analysis of fission product mixtures. Part 1. Recognition of radiochemical purity using aluminium absorption curves. Atomic Energy Res. Estab. (Gt. Brit.) c/R-1534, 20 p. 1954.

"Results of a study on methods for the analysis of mixed fission products for an individual radioelement show that the Automatic Absorber/Sampler Changer Type 112A may be used to obtain reproducible aluminium absorption curves under fixed conditions of source weight, mounting, and geometry. The reproducibility is maintained with successive sources, Geiger tubes, and Automatic Absorber Changers. A library of standard absorption curves is presented for many of the common fission products mounted on 30 mg. of carrier precipitate and spread over a deep aluminum tray." (Nuclear Sci. Abs. 9: 4244.)

1152. ROSINSKI, J. Efficiency of scavenging devices in determining fallout. U.S. Atomic Energy Comm. AECU-3547, 40 p. 1957.

A fallout sample collector was designed and tested for use in collecting samples at the soil surface. The sampler consists of artificial grass and a stainless-steel pot. Results are included from preliminary studies on the scavenging properties of artificial grass. The effects of relative humidity, rain, and wind velocity on the efficiency of scavenging devices were investigated. A comparison was made of Sr^{90} fallout data from samples collected on gummed film and surface soil samples from various locations. Preliminary experiments were performed for the evaluation of devices used in determining air concentration of radioactive fallout or other particulate matter. (For preceding period, see AECU-3435.)

1153. ROSINSKI, J. Evaluation of gummed-paper collectors used in determining radioactive fallout. Amer. Geophys. Union Trans. 38: 857-863. 1957.

"The gummed-paper collector for particulate matter was evaluated for various conditions. On the basis of wind-tunnel tests, it is concluded that only a fraction of small particles is collected because of settling; most particles are scavenged through turbulence and electrostatic forces. The quantity collected is a function of wind velocity and humidity, which affect the formation of an electrostatic field. Collection from rain is affected by whether the material is sol., hydrophilic, or hydrophobic. Evidence is presented to show that radioactive particulate matter present in rain is water-sol., or hydrophilic, or both. A gummed-paper sampler is not adequate for collection under dry conditions or during rain storms." (Chem. Abs. 52: 8759.)

1154. SCHILZ, W. E., and KRYNAUW, G. N. Determination of calcium and magnesium in foodstuffs. Simultaneous removal of iron and phosphate as interfering ions by ion exchange. Analyt. Chem. 28: 1759-1761. 1956.

"A titration method using ethylenediaminetetraacetate is described for the routine determination of Ca^{++} and Mg^{++} in foodstuffs in which Fe and PO_4 occur in interfering amounts. Murexide and Eriochrome Black T are used as indicators for Ca^{++} and Mg^{++} respectively. The Fe is converted into an oxalate deriv. and removed with phosphate on a cation exchanger in the H form. Metals are eluted with HCl . Results compare favorably with those obtained by the classical method." (Internat. Abs. Biol. Sci. 6: 5563.)

1155. SEVERINGHAUS, J. W., and FERREBEE, J. W. Calcium determination by flame photometry. Meth-

ods for serum, urine, and other fluids. *Jour. Biol. Chem.* 187: 621-630. 1950.

"Serum is dild. 1:10 and the protein pptd. with $\text{CCl}_3\text{-COOH}$. Other fluids are dild. so that the concn. of Ca is in the range of 0.1 to 1.0 milliequivs./l. Ca measurements are made with the Beckman quartz spectrophotometer with a flame attachment, and the intensity is measured at the 556 $\text{m}\mu$ CaO line. A correction for the effect of variations in Na and K concn. may be made. The method is accurate to within 1%." (*Chem. Abs.* 45: 3451.)

1156. SOBEL, A. E., and HANOK, A. A rapid method for determination of ultramicro quantities of calcium and magnesium. *Soc. Expt. Biol. and Med. Proc.* 77: 737-740. 1951.

"Serum Ca and Mg are detd. by titration with standard disodium (ethylenediamine)-tetraacetate soln. in the presence of eriochrome black T indicator at pH 10.0-10.5. The serum (0.02-0.05 cc. dild. with 0.5 cc. of buffer soln.) is titrated directly and in less than 1 min. For rapid and approx. Ca values, the mean Mg concn. of human serum (1.64 milliequivs./l.) is subtracted from the total Ca plus Mg value thus obtained. For more precise Ca values, Mg is detd. in an aliquot of serum by the method of Orange and Rhein (*C.A.* 45: 5226b) and subtracted from the total; for precise Mg values Ca is detd. by the method of Sobel, et al. (*C.A.* 38: 23585) and subtracted." (*Chem. Abs.* 45: 10284.)

1157. TAUSSKY, H. H. A micro method for the separation and determination of Ca and Sr in biological fluids. *Fed. Proc.* 16: 261. 1957.

"The separation of Ca from Sr, ordinarily a time-consuming procedure, has been simplified into a two-step method. Ca and Sr are precipitated as the oxalates in duplicate. One precipitate is used for the determination of the sum of both Ca and Sr, the other for the separation procedure. Sr is separated from the Ca at boiling-water bath temperature as the sulfate. Ca is left in solution and is then again precipitated as the oxalate. Sr is calculated as the difference between the titrations for the sum and for the Ca. The completeness of the separation of Ca and Sr is a function of the amounts of Ca and Sr present in the solution. Conditions are established under which, between certain limits of concentration, the separation is complete and coprecipitation is avoided. Direct precipitation of the oxalates from urine gives incorrect, high results because other substances also precipitate with oxalate. This interference is eliminated by preliminary treatment with iodine. Except that a new wash liquid is utilized, in which the oxalates of Ca and of Sr are practically insoluble, the final titration of the oxalates is carried out in the

classical way with KMnO_4 . However, the procedure is also applicable to EDTA titration. Recovery experiments are satisfactory." (Author's abstract.)

1158. TSAO, M. U. Colorimetric determination of serum calcium. *Jour. Biol. Chem.* 199: 251-257. 1952.

"A rapid colorimetric method for the detn. of Ca in serum is presented; it is based on the reaction of Ca with 2,3,4-(HO) $_3$ C $_6$ H $_2$ COOH (cf. von Hemmelmayr, *C.A.* 12, 275) to form a violet-blue color. A linear relation exists between the concn. and absorbency of the color for the entire range of application, 5-18 mg. %. With 0.5 cc. serum, 4-18 mg. % Ca can be detd. with a standard deviation of 2%." (*Chem. Abs.* 47: 1221.)

1159. TURK, E. A modified radiochemical strontium procedure. *U.S. Atomic Energy Comm. ANL-5184*, 7 p. 1953.

1160. VOLCHOK, H. L., and others. Determination of Sr 90 and Ba 140 in bone, dairy products, vegetation, and soil. *N.Y. Acad. Sci. Ann.* 71: 293-304. 1957.

J. L. Kulp, W. R. Eckelmann, and J. E. Gaetjen, joint authors.

Procedures for low-level counting of fallout Sr 90 and Ba 140 are described.

1161. ZAK, B., HINDMAN, W. M., and BAGINSKI, E. S. Spectrophotometric titration of spinal fluid calcium and magnesium. *Analyt. Chem.* 28: 1661-1665. 1956.

"Standardize Ca soln. by pptg. Ca oxalate from 1.0 ml. Ca standard soln. (250 mg. CaCO_3 in 1 l. water contg. min. amt. HCl) in a cuvet with 1.0 ml. water + 2.0 ml. pptg. buffer (1.5 g. NH_4 oxalate, 0.35 ml. concd. NH_4OH + 3.5 g. NH_4Cl in 250 ml. water). Let stand 1 hr., wash once with 2% NH_4OH . Add 0.05 ml. 72% HClO_4 for pptn., and place in hot sand bath 10 min. Cool, add 3.0 ml. water + 3.0 ml. titrating buffer (67.5 g. NH_4Cl + 570 ml. concd. NH_4OH to 1 l. with water) and 0.2 ml. of 0.1% aq. Eriochrome Black T soln. Place cuvet in spectrophotometer and set absorbance to 0.050-0.100 at 660 μ . Add small increments of titrant (400 mg. ethylenedinitrilotetraacetic acid + 4 NaOH pellets + 10 mg. Mg as MgCl_2 to 1 l. with water), mixing well between addn. until a max. absorbance is obtained. Treat 1.0 ml. of Mg standard soln. (contg. 5 mg. per 100 ml.) as above, by using 3.0 ml. of centrifugate for sample titrated. For spinal fluid analysis use 2.0 ml. of fluid + 2.0 ml. of pptg. buffer, and proceed as above. Calens. are made from standard curves. Dye variance, compn. of titrant, spectral studies, and accuracy and precision were examd." (*Chem. Abs.* 51: 2107.)

SUBJECT INDEX

	Item		Item
Absorption, amino acids and Ca, Sr	141	Analysis, for barium	1131, 1133, 1135, 1150, 1160
of calcium	100, 101, 106, 126, 144, 158, 198, 207, 212, 214, 217, 241, 254, 872, 874, 877, 878, 879	of biological fluids	1127, 1128, 1155, 1157
of calcium, by fish	107, 125, 129, 229, 239	of bone	1124, 1126, 1132, 1148, 1159
by man	107, 109, 110, 113, 119, 126	for calcium	1121, 1124, 1127, 1128, 1130, 1131, 1132, 1134, 1138, 1139, 1140, 1143, 1147, 1148, 1149, 1150, 1154, 1155, 1156, 1157, 1158, 1161.
by rats	112, 117, 118, 120, 126, 141, 142	for endogenous phosphorus	1142
of calcium and Sr	100, 101, 106, 126	of excreta	1136
of fission products	114, 115, 123, 124	of fallout	909, 910, 911, 912
of phosphorus	131, 135, 136, 137	for fission products	1145, 1151
of phosphorus supplements	153, 154, 155, 156, 157	of food	1126, 1154, 1159
of plutonium	115	of kidney decalcification	1121
of strontium	100, 101, 106, 126, 231, 241, 251, 252, 816	for magnesium	1127, 1130, 1137, 1138, 1154, 1156, 1161
of strontium, by chick	139, 142	of milk	1126, 1138, 1159
by fish	248	for potassium	1130, 1140, 1148
by rats	111, 121, 122, 126, 130, 141	of rocks	1150
by skin	189, 190, 191, 192	of serum	1130, 1139, 1147, 1156, 1158
of tricalcium phosphate	144	for sodium	1124, 1130, 1140, 1148
of vitamin D and Ca	118, 616, 633, 635, 639, 641, 642, 643, 644, 645, 905	of soils	1144, 1159
Acidosis, plasma Ca in	282	of spinal fluid	1161
Actinide elements, metabolism	23	for strontium	1123, 1126, 1129, 1131, 1132, 1133, 1134, 1135, 1136, 1141, 1144, 1145, 1146, 1150, 1157, 1159, 1160
Activation analysis, for strontium and Ba	220, 485	of tissues	1122
for trace elements	1125, 1135	of urine	1133, 1145
Adenosine phosphate, calcium and Mg complex	276	of water	1123, 1129, 1144, 1145
complexes with	287, 288	of whole body	1146
Adenosinediphosphate, calcium complexes	413	Animals, composition of	470
Adenosinetriphosphate, in calcification	438	minerals in	12, 13, 14, 15, 21, 46, 71
calcium complexes	413	nutrition	38
in cartilage	409, 412, 438	trace elements in	572, 573
Adrenal steroids, and calcium	727, 736	Anions. (See Minerals.)	
Adrenalectomy, and strontium	764	Anterior pituitary, and bone growth	767
Adsorption. (See Bone, calcium exchange in.)		Aquatic organisms. (See Fish.)	
Aerosols, of fission products	958, 1015	Arginine, and calcium, Sr absorption	141
Age, and bone composition	466	Arteriosclerosis, effects of	906
and bone growth	833, 834, 835	Artificial kidney	1100
and calcium metabolism	213, 291, 296, 297, 553, 827, 828, 829, 830, 831, 832, 836	Ascorbic acid. (See Vitamin C.)	
and calcium requirement	558	Assay, for hypophyseal hormone	760
and metabolism of fission products	825	for parathyroid	681c, 701
and phosphorus metabolism	824	for vitamin D	648, 650, 665b
and rickets	836	A.T.	12
and sodium metabolism	826	in rickets	659
and strontium metabolism	225, 228	Atomic energy, general	18, 20, 43, 60, 64
Agents, for radioisotope removal	1084, 1094, 1095	Atomic weapons, effects of	941, 953, 956, 957
Aging, and diet	834	Aureomycin, effect on calcium absorption	885
Agriculture, radioisotopes in	11, 32, 51	Autoradiography	9
Alizarin, use in bone studies	370	bone	479, 837, 838, 842
Alkaline earths (see also Barium, Calcium, Strontium).		calcium in	294, 295, 296, 297, 300, 312, 325, 326, 366, 367, 368
amino acid complexes of	284, 286	fission products in	304, 309
biochemistry of	29	grafts	316, 355
biological mechanisms	360	metabolism	356, 365, 376, 377, 378
in bone	160, 998	phosphorus in	326
and calcification	416	radium in	295
and chelation	188	radium and Th in	340
complexes	287, 288	strontium in	314, 315
Alkaline phosphatase, in calcification	419	uranium in	292
and corticoids	721, 734	and cancer	1042
and radiation	1028	of teeth	499, 505, 506, 612
in rickets	594, 608, 640, 647	Availability, of calcium	143, 144, 145, 148, 149, 150, 151, 152, 155, 156, 158
Alkalosis, plasma Ca in	282	of calcium and P in diet	155, 156, 158
Alpha emitters, in bone	1000, 1033, 1043, 1055, 1056, 1057	of phosphorus supplements	153, 154, 156, 157
Amino acids, and calcium, Sr absorption	141	of strontium	146
complexes of	284	Axons, calcium in	184
incorporation into milk proteins	800	calcium transport in	199
Ammonium chloride, and strontium* removal	1084		

*Radioactive.

	Item
BAL, and polonium.....	1087
and strontium ⁹⁰	1091
Barium, activation analysis.....	220
analysis for.....	1131, 1133, 1135, 1150, 1160
in bone.....	485
and calcium.....	79
in insects.....	498
in man.....	485
Bibliography on fallout.....	27, 28, 41, 72
Bicarbonate, calcium complex.....	277
Bile, calcium and Sr in.....	86, 99
Binding. (See Complexes.)	
Bioassay, for radioisotopes.....	1014
Biochemistry, alkaline earths.....	29
of bone.....	8, 36, 47, 48, 50, 54, 55, 56, 68, 69, 73
general.....	4
Biological fluids, analysis of.....	1127, 1128, 1155, 1157
Biological mechanisms, for alkaline earths.....	360
for rare earths.....	360
Biology, autoradiography in.....	9
radiation in.....	1, 30, 53, 66, 70
radioisotopes in.....	11, 24, 25, 32, 37, 51
standard data.....	67
Biophysics, general.....	10, 44
Biosphere (see also Food chain)	
strontium and Ca in.....	81
Biotic cycle. (See Food chain.)	
Birds, estrogens in.....	724, 726, 732, 747
Blood	
calcium in.....	145,
158, 263, 282, 523, 807, 808, 823, 852, 891	
calcium and P levels in.....	574
fission product effects on.....	972
magnesium in.....	852
minerals in.....	461, 478, 689
minerals and vitamin D.....	655
phosphorus in.....	478, 823
radiation effects on.....	1062
strontium in fish.....	165
vitamin A in.....	478
Body, analysis of whole.....	1146
Bone (see also Calcification)	
alkaline earths in.....	998
alpha emitters in.....	1000,
1033, 1043, 1055, 1056, 1057	
analysis of.....	1124, 1126, 1132, 1148, 1159
analysis by X-rays.....	496
autoradiography of.....	479
barium content of.....	485
calcium in.....	294, 295, 296, 297, 311, 312, 322, 326,
330, 423, 432, 466, 837, 840, 841, 842	
calcium exchange in.....	383, 385, 387,
389, 391, 392, 393, 394, 395, 396, 397, 398, 401, 406	
calcium redistribution.....	330
calcium and Sr in.....	89, 90, 105
calcium, urinary, as indicator of metabolism.....	242
chloride content of.....	473
composition of.....	460, 497, 566, 581
composition and effect of Sr ⁹⁰	1016
density of.....	583
density estimates.....	472
dosimetry.....	1019
effect of vitamin D.....	588, 592, 645, 654, 663
electron microscopy of.....	471, 486
elements in.....	16, 56, 68, 69, 73, 160
esterase in.....	353
fission products in.....	305, 306, 307, 309, 333
fluorine effect.....	837, 838, 839, 840, 841, 842, 847
formation of.....	35, 36, 47, 50, 55, 56, 68, 69, 73
fracture studies.....	325
general.....	8,
36, 42, 47, 48, 49, 50, 54, 55, 56, 63, 68, 69, 73	
grafts of.....	316, 317, 334
heavy elements in.....	308, 309, 333
histochemistry of.....	482, 839, 970
histogenesis of.....	415
histology of.....	580
lead in.....	319
lead exchange in.....	389

	Item
Bone, on low calcium diet.....	532, 533
mechanisms in.....	320
mineral structure of.....	36, 56, 61, 68, 69, 73
minerals in.....	496
mobilization from.....	532, 533, 535
mycotoxicosis effect.....	889
organic acids in.....	477
and parathyroid.....	686,
695, 696, 697, 700, 711, 712, 713, 720	
pathology in.....	474, 1036, 1038, 1053, 1069, 1070
phosphorus in.....	301, 318, 326, 428a, 428b, 466
phosphorus exchange in.....	388, 397, 406
phosphorus in grafts of.....	317
physiology of.....	323
plutonium in.....	333, 335, 341
radiation effects on.....	1023,
1027, 1033, 1034, 1036, 1038, 1039, 1041, 1055, 1056,	
1057, 1059, 1063.	
radioisotope deposition in.....	1012
radioisotope exchange in.....	397
radioisotopes in.....	304,
310, 323, 325, 331, 332, 334, 337, 339	
radium and Th.....	340
radon in.....	384
repair of.....	483
rickets by Sr.....	450,
451, 453, 454, 455, 457, 458	
and sarcoidosis.....	896
sodium exchange in.....	386
solubility of.....	480
somatotrophic hormone and.....	766
strength of.....	484
strontium in.....	17,
139, 226, 299, 302, 303, 305, 306, 313, 314, 315,	
319, 320, 321, 324, 327, 329, 335, 356, 363, 462,	
475, 485, 492, 565.	
strontium and Ca deposition in.....	320, 321
strontium in dead.....	327
strontium fixation in.....	400
strontium rickets in.....	450, 451, 453, 454, 455, 457, 458
strontium ⁹⁰ pathology.....	994,
995, 1008, 1009, 1048, 1052, 1054	
structure.....	49, 56, 61, 68, 69, 73, 359, 467, 468, 493, 495
sulfur in.....	837
sulfur exchange in.....	397
sulfur ³⁵ effects on.....	1010
surface chemistry of.....	402, 403, 404, 405, 407, 408
and thyroid.....	751, 752a, 753, 754
tissue culture.....	90
tumors and mineral content.....	1070
uranium in.....	292
uranium deposition.....	568
vascularity of.....	375
water exchange in.....	386
yttrium in.....	298, 335, 384
Bone clearance, of Ca.....	361
Bone density. (See Bone, density of; Bone growth.)	
Bone disease.....	373
Bone fracture, and Sr.....	989
and vitamin C.....	668
Bone grafts (see also Bone, grafts of)	
radioactive tracer studies of.....	355
radiostrontium tracer studies of.....	371
Bone growth (see also Bone metabolism)	
and age.....	833, 834, 835
and anterior pituitary.....	767
assay for.....	660
and calcium levels.....	576
calcium,* in studies of.....	338,
343, 346, 366, 367, 368, 382	
and cortisone.....	624, 740, 743
effect of Ca.....	537, 576
effect of deficiencies.....	550
effect of P.....	537, 579
enzymes in.....	410, 417
factors affecting.....	493
and gland extracts.....	897, 898

*Radioactive.

	Item		Item
Bone growth, and hormones	673, 677, 763	Calcium, and age	553, 827, 828, 829, 830, 831, 832, 836
lead,* in studies of	342	age effects	213, 296, 297
method for estimating	349, 376, 377, 378, 382	amino acids and absorption	141
phosphorus,* in studies of	344, 346, 348, 350, 351, 358	analysis for	1124, 1127, 1128, 1130, 1131, 1132, 1134, 1138, 1139, 1140, 1143, 1147, 1148, 1149, 1150, 1154, 1155, 1156, 1157, 1158, 1161.
and protein	550, 882	ATP complexes	413
radioisotopes, in studies of	356, 362	aureomycin effects	885
radium, in study of	342	availability	143, 144, 145, 148, 149, 150, 151, 152, 155, 156, 158
and riboflavin	619	in axons	184, 199
and strontium ⁹⁰	944	bicarbonate complex	277
sulfur,* in study of	366, 367, 368	binding	908
and vitamin B ₁₂	619	binding in blood	698
and vitamin D	537, 614, 645, 654, 663	in blood	132, 142, 145, 158, 263, 282, 461, 478, 807, 808, 823, 852
Bone healing (<i>see also</i> Fracture healing)		in blood of hen	523
strontium ⁸⁵ , in studies of	363	blood studies	891
Bone marrow, calcium in	280	in blood and urine	263
Bone matrix, fluorine and	838, 839	in bone	89, 90, 322, 326, 330, 423, 432, 837, 840, 841, 842
Bone metabolism (<i>see also</i> Bone growth)		bone clearance	361
alizarin, in study of	370	bone in deficiency of	580
calcium in	376, 377, 378, 379, 382	in bone grafts	355
and hormones	746	for bone growth	338, 343, 346, 366, 367, 368, 376, 377, 378, 382
lead, in study of	370	in bone of horse	466
lead and Ra, in study of	342	in bone marrow and platelets	280
surfaces and	402, 403, 404, 405, 407, 408	bone metabolism	376, 377, 378, 379, 382
Bone mineral, calcium exchange in	391, 392, 393, 394, 395, 396, 397, 398, 401, 406	bone redistribution	330
structure of	399, 402, 403, 404	in bones and teeth	293, 294, 295, 296, 297, 311, 312
Bone physiology, general	372	in cartilage	300, 424, 425, 431
Bone strength, and radioisotopes	364	in casein	133, 134
Bone structure, from strontium and Ra	384	casein binding	900
Bone tumors (<i>see also</i> Toxicity)		in cattle	116, 126, 148, 156, 198, 661, 770
strontium in	380	in cerebrospinal fluid	262, 263
Bonemeal, calcium and P from	154	in chicken	161
effect on iron	546, 547, 549	children, intake in	539
Boron, metabolism of	175	and citrate	856, 863, 1080
Bovine. (<i>See</i> Cattle.)		complexes	273, 276, 277, 283, 284, 286
Brain function, and mineral metabolism	510	and complexing agents	858, 865
Calciferol, and parathyroid	692	conservation of	221, 222, 223
and phosphorus metabolism	595	and cortisone	680c, 731, 738
Calcification (<i>see also</i> Bone)	47, 68, 69, 73	deficiency and vitamin D	601, 612
and alkaline earths	416	in dental tissues	266
alkaline phosphatase in	419	in dentin	197
ATP in	438	dietary levels and bone growth	576
and carbohydrates	875, 876, 877, 878, 880	dietary, sources of	149, 150, 151, 152, 158
chondroitin sulfate in	437	dietary supplements	577
effect of cyanide	441	dihydrotachysterol and	589, 636
effect of F on	441	drug effects	725, 907
effect of Sr on	422	and EDTA	1073, 1076, 1078, 1086, 1102, 1103, 1113, 1116
and ergosterol	633	effect, on bone	540, 541
and estrogens	722, 723, 730, 749, 750	on bone growth	537, 576
fluorine in	843, 844	of carbonated water	564
glycolysis in	439	of dietary level	542, 544, 551, 553, 554, 557, 559, 561, 569, 574
and hormones	418	of excess	574
inhibition of	420, 441, 442, 444, 884	on eye	87
and lysine	892	of i.v.	205
magnesium in	441, 442	on iron	546, 547, 549
mechanisms of	416, 436, 440, 441, 443, 444, 445, 446, 447	on lead removal	578
in mollusks	163, 411	on liver	538
and parathyroid function	418	of low levels	581
pathological	426	on molybdenum metabolism	536
phosphate metabolism	504	on phosphorus in diet	563
phosphate solubilities and	421	on phosphorus metabolism	536
phosphopeptides in	640, 649	on strontium	243
strontium in	442, 444	on strontium uptake	562, 570, 582
strontium, in studies of	456	on tissue metabolism	538, 540, 541
and thyroid function	418	of vitamin D	590, 598, 602, 612, 616, 620, 622, 623, 632, 635, 639, 641, 642, 643, 644, 645.
thyroxine and	722	of water on	209
variations in	427	in eggs	517, 519, 520, 524, 525, 526, 529, 530, 531, 534, 535
Calcified tissues. (<i>See</i> Bone.)		from eggshell	522, 527
Calcium, absorption	107, 109, 110, 112, 113, 116, 117, 118, 119, 120, 126, 135, 136, 137, 141, 142.		
absorptions and sugars	872, 874, 877, 878, 879		
ADP complexes	413		
adrenal steroids and	727, 736		

*Radioactive.

	Item
Calcium, eggshell variations in	535
in embryo	519, 520, 522, 527, 858
endogenous	207, 208, 212, 254, 542
and estrogens	724,
726, 729, 732, 735, 737, 741, 742, 747	
exchange, in bone	383,
385, 387, 389, 391, 392, 393, 394, 395, 396,	
397, 398, 401, 406.	
in fossils	390
and fat	868, 903, 904
in fish	125, 129, 159, 196, 229, 239
fixation in bone	383,
385, 387, 389, 391, 392, 393, 394, 395, 396, 397,	
398, 401, 406.	
and flourine	845, 846
food content	560
in fracture healing	345, 357, 369, 374
in gargolism	168, 208
from gypsum	849
in Haversian systems	365
and heart contraction	279
homeostatic effect	672
and hormones	677
in insects	186
intake in children	539
intermittent consumption	561
and lactation	773,
778, 795, 796, 797, 810, 812, 815, 817, 818, 819	
in liver	267
liver binding	832
and low mineral diet	1077
lymphoid effects	890
lysine on absorption of	141, 905
metabolism of	10,
22, 31, 34, 62, 110, 116, 117, 118, 127, 138, 147,	
148, 167, 168, 169, 194, 205, 206, 207, 208, 212,	
213, 214, 216, 217, 221, 222, 223, 237, 238, 241,	
242, 244, 247, 254, 255, 258, 289, 291, 293, 294, 295,	
544, 551, 553, 554, 561, 563, 569, 574, 964, 998.	
metabolism in cows	795, 796
metabolism in hen	521,
524, 526, 529, 530, 531, 534, 535	
into milk	769, 791, 794
milk and absorption	126
milk content	781
milk effect on	870, 873
and milk fever	543
mobilization of	693, 700
in muscle	268, 270, 278
niacin effect on blood	671
and parathyroids	680a,
680c 681b, 683, 684, 685, 687, 691, 693, 694, 698,	
699, 700, 701, 702, 703, 704, 705, 710, 712, 713,	
716, 717, 720.	
parathyroids and blood level	523
and parturient paresis	768, 772, 775, 820
penicillin effect	867
phosphopeptides and	133, 134
phosphorylation and	267
and phytates	848, 849, 850, 851, 857, 862
in platelets and bone marrow	280
and pregnancy	773,
777, 783, 788, 795, 799, 803, 811, 819	
protein binding	260, 269, 271, 274
and radium	76, 102, 244, 295
and radium and Sr	92
renal excretion	209, 211, 216,
234, 237, 238, 241, 242, 247, 255, 258, 674, 852	
requirements	143, 156, 558
in rickets	213, 621, 640, 652, 665a
in salivary glands	172, 265
in shell formation	224, 448
and sialoadenectomy	752b, 755, 766
skin transport	203
sodium antagonism	279
in soft tissues	162
sources of dietary	149, 150, 151, 152, 158

	Item
Calcium, and strontium	75, 77, 78, 80, 81, 82,
83, 84, 85, 88, 91, 93, 98, 100, 101, 105, 106, 452	
in bile	86, 99
in fetus	85, 106
in fish	94, 95, 96
in shells	103
transport	97
supplements	154, 156, 158, 584
in teeth	312, 499, 500, 501, 503, 505, 506, 508, 511
and testosterone	733, 739, 745
therapy	289
in tumors	259
and ultraviolet	869
and zinc	886, 893
Calcium ⁴⁵ , analysis for	1121, 1149
effect on hens	528
removal from body	1099, 1117, 1119
removal from milk	1105
therapy with	1060, 1061
toxicity of	992, 993, 1029, 1030, 1049
Calcium ⁴⁷	77
Calcium carbonate, absorption	144, 158
Calcium metabolism, and hypophysis	758
and thyroid	753
Calculi, in rats	575
Calves. (See Cattle.)	
Cancer (see also Toxicity)	
autoradiography in	1042
chemotherapy in	1046
Carbohydrates (see also Sugars)	
and calcification	875, 876, 877, 878, 880
Carbon ¹⁴ , atmospheric	928
Carbonated water, on Ca metabolism	564
Carcinogenesis. (See Toxicity.)	
Cardiovascular system, factors regulating	618
Caries, metabolism in	501, 502, 507
Carrier effects	1108
Carrier, and strontium*	1089
Cartilage, ATP in	409, 412, 438
calcium in	300, 424, 425, 431
cocarboxylase in	410
composition of	460
electron microscopy	354
factors affecting	424, 425, 428b, 430
and glycogen	895
glycolysis and	414, 429, 430, 434
phosphorus in	431
strontium in	328, 424, 425
structure of	354
sulfur in	336
and sulfur	762
Casein, and calcium absorption	133, 134
calcium binding and	900
phosphorus into	813, 814
Cat, parathyroid	682
vitamin D studies	617
Cation. (See Minerals.)	
Cattle, age studies	829, 830
blood studies in	574
bone strength of	484
bone structure in	493
calcium in	148, 156, 198, 212, 254, 770
calcium metabolism in	116, 661
calcium requirements	143, 156
citric acid in	771
fission product studies	776, 782, 790, 793
iodine ¹³¹ in thyroid of	916
lactation studies in	773,
776, 778, 781, 782, 791, 792, 794, 795, 796, 797,	
798, 800, 801, 802, 804, 805, 807, 808, 810, 815,	
818, 820.	
magnesium metabolism in	661
milk fever in	543
parathyroid	708, 709
parturient paresis in	768, 772, 775, 820
phosphorus requirements	143, 153, 156, 157
phytate studies in	855

*Radioactive.

Item	Item
Cattle, pregnancy studies in..... 784, 803	Dental tissues, calcium in..... 266
vitamin D in..... 597, 598, 628	Dentin, calcium in..... 197
vitamin D requirements..... 653	Diabetes, calcium in..... 672
Cerebrospinal fluid, calcium in..... 262, 263	Diet, and aging..... 834
entry of ions..... 177	and calcium..... 1077
magnesium in..... 262	calcium supplements..... 577
Cesium, in foods..... 933	effect on bone composition..... 566
surveys, fallout..... 913, 933	on bone density..... 583
Chelation (<i>see also</i> Agents, EDTA)	on bone strength..... 484
of alkaline earths..... 188	of low calcium..... 581
and eggshells..... 525	on uranium deposition..... 568
and teeth histology..... 1079	low calcium, in hens..... 532, 533
Chemistry, of bone. 36, 47, 48, 50, 54, 55, 56, 61, 68, 69, 73	protein supplements..... 577
nuclear..... 19, 64	and strontium..... 1077
radio..... 19, 64	and vitamin D..... 597
Chemotherapy, in cancer..... 1046	Diethylstilbesterol, and blood calcium..... 524
Chick, strontium in..... 139, 142	Diets, strontium and Ca in..... 80, 81
Chicken (<i>see also</i> Hen)	for strontium removal..... 556
calcium in..... 161	Dihydrotachysterol, and calcium..... 589, 636
calcium studies in..... 867, 905, 1076	and strontium removal..... 556
and parathyroid..... 704	Discrimination, barium and Ca..... 79
phosphorus in..... 579	placental..... 85, 106
strontium in..... 609	radium and Ca..... 76, 102
vitamin D and Ca absorption..... 616,	strontium and Ca..... 75, 77, 78,
632, 640, 641, 642, 643, 644, 651, 664	80, 81, 82, 83, 84, 85, 88, 91, 98, 100, 101, 105, 106
Chloride, in bone..... 473	Dissociation, of calcium complexes..... 273, 283, 284, 286
metabolism of..... 902	Distribution in tissues. (<i>See</i> Metabolism.)
Chondroitin sulfate, in calcification..... 437	Dog, blood mineral studies..... 689, 700
Chondrosarcoma, and sulfur ³⁵ 1010	calcium in..... 216, 237, 244, 255, 258, 266, 295
Citrate, and calcium..... 856, 863, 1080	calcium in bone of..... 423
on metabolism..... 854, 860	calcium exchange in..... 389
and rickets..... 854, 860	calcium and radium in..... 76, 102
and strontium..... 853, 864, 1080, 1084	calcium studies..... 1099
and vitamin D..... 585, 588, 603, 606, 607, 611, 631, 662	fission product studies..... 1100
Citric acid (<i>see also</i> Citrate)	hormone studies..... 745
effect of, at parturition..... 771	lead exchange in..... 389
and parathyroid..... 683, 684, 711, 712	parathyroid..... 697
Citrogenase, and vitamin D..... 607, 631	radium in..... 253, 295
Clay, effect on Sr absorption..... 111	radium in bone of..... 340
Coccarboxylase, in cartilage..... 410	sperm studies..... 1068
Collection, of fallout..... 1152, 1153	strontium in..... 174, 175, 230, 240, 245, 246, 249, 252
Complexes, with calcium..... 273, 276, 277, 283, 284, 286	strontium* studies in..... 1003, 1035
and conductivity..... 290	teeth composition..... 515
factors affecting..... 283, 286	Vitamin B, deficiency in..... 587
with magnesium..... 276	Vitamin D studies..... 611, 612, 631
Complexing agents, and calcium..... 858, 865	Dosimetry, of bone..... 1019
for radioisotope removal..... 1108	general..... 26
and strontium..... 853, 864	with radioisotopes..... 997
and thorium..... 864	of strontium ⁹⁰ 1001
Composition (<i>see also</i> specific tissue or species)	Drugs, on calcium..... 726, 907
of mammary gland..... 786, 787, 788	on teeth..... 883
of milk..... 804, 810, 822	
of parathyroid..... 705	EDTA (<i>see also</i> Agents, Chelation)
Conductivity, and mineral complexes..... 290	and calcium metabolism..... 1073,
Connective tissues, calcium in..... 162	1076, 1078, 1086, 1102, 1103, 1113, 1116
minerals in..... 261	and fission products..... 1074, 1120
Conservation, of calcium..... 221, 222, 223	and lead..... 861
Contamination, by fission products..... 23,	lesions from..... 1112
27, 28, 41, 52, 65, 72, 939	and magnesium..... 1078
of oceans..... 52	metabolism of..... 1071
Corticoids, and alkaline phosphatase..... 721, 734	and plutonium..... 1118
and ergocalciferol..... 679	and radioisotopes..... 1081
and phosphorus..... 748	and renal function..... 1109
Cortisone, and bone growth..... 624, 740, 743	and strontium..... 89, 1075, 1082, 1090, 1115
and calcium..... 731, 738	and yttrium..... 1088, 1090
and calcium and Sr..... 680c	Effects, of fallout..... 27, 28, 41, 72
and yttrium metabolism..... 676	of radiation... 1, 5, 30, 39, 45, 53, 57, 66, 70, 991, 1007
Cows. (<i>See</i> Cattle.)	radiation, in oceans..... 52
Cyanide, effect on calcification..... 441	Egg laying, vitamin D and Ca..... 486
Dairy cows. (<i>See</i> Cattle.)	Eggs, calcium in..... 517,
Damage. (<i>See</i> Toxicity.)	519, 520, 524, 525, 526, 529, 530, 531, 534, 535
Daughters, of strontium and Ra..... 384	and chelation..... 525
Decalcification, in strontium rickets..... 453,	composition of..... 518
454, 455, 457, 458	minerals in..... 518
Decontamination (<i>see also</i> Removal)	phosphorus in..... 524, 526, 529, 530, 534
of fission products..... 114	strontium in..... 516
Dental studies (<i>see also</i> Teeth)	
autoradiography..... 368	

*Radioactive.

Item	
Eggshells (<i>see also</i> Eggs)	
calcium from	522, 527
calcium variations in	535
Electrolytes. (<i>See</i> Minerals.)	
Electron microscopy, of bones and teeth	471, 486
of cartilage	354
Electrophoresis, of calcium in dentin	197
Embryo, calcium in	519, 520, 522, 527, 858
Enamel. (<i>See</i> Teeth.)	
Endocrine. (<i>See</i> Hormones.)	
Endogenous phosphorus, analysis for	1142
England. (<i>See</i> Great Britain.)	
Enzymes, in bone growth	410, 417
in mammary gland	821
metals in	74
Ergocalciferol, and corticoids	679
and vitamin D content	604
Ergosterol, and calcification	633
and strontium	609
Erythrocytes, phosphorus entry	888
Esterase, in bones and teeth	353
Estradiol, and parathyroid	699
Estrogens, in birds	724, 726, 732, 747
and calcification	722, 723, 730, 749, 750
and calcium metabolism	724,
726, 729, 732, 735, 737, 741, 742, 747	
and mineral metabolism	728
and phosphorus	735
and sulfur	729
and teeth	744
Ethylenediaminetetraacetic acid. (<i>See</i> Chelation, EDTA.)	
Exchange. (<i>See</i> Bone, calcium exchange in.)	
Excreta, analysis of	1136
Excretion, of calcium	255, 258
of radium and Th	232, 235
of strontium	252, 256, 257
External radiation and strontium ⁹⁰	1001
Eye, calcium and Sr effects	87
Fallout, analysis of	909, 910, 911, 912
bibliography	27, 28, 41, 72
collection of	1152, 1153
general	27, 28, 41, 72, 934, 947, 948, 954, 956, 957
and grazing animals	954
in Great Britain	913
of iodine ¹³¹	916
iodine values	931
and man	915, 956, 957
in Norway	909, 910, 911, 912
strontium ⁹⁰ from	936, 947, 948
surveys	909,
910, 911, 912, 913, 917, 918, 919, 920, 921a, 921b,	
922, 923, 924, 925, 926, 927, 929, 930.	
toxicity from	975, 977, 1021
in United States	917,
918, 919, 920, 921a, 921b, 922, 923, 924, 925, 926,	
927, 930, 931.	
worldwide	929
Fat, and calcium	868, 903, 904
and hormones	738
in mammary gland	805
and phosphorus	868, 903
Feed. (<i>See</i> Diet.)	
Fetal transfer. (<i>See</i> Pregnancy.)	
Fetus, strontium and Ca in	85
strontium transfer to	251
Fish, calcium in	159, 196, 229, 239
calcium and P absorption	125, 129
calcium and Sr in	94, 95, 96, 108
fission products in	164, 187, 195
strontium in	165, 166, 182, 183, 185, 248, 250
strontium assay	914
Fisheries, and radiation	52
and radioactivity	950
Fission products (<i>see also</i> individual fission products, e.g., Iodine, Strontium)	
absorption of	114, 115, 123, 124
aerosols of	958, 1015

Item	
Fission products, age and metabolism	825
analysis for	1145, 1151
blood effects	972
in bone	305, 306, 307, 309, 333
contamination with	939
and EDTA	1074, 1120
in fish	164, 187, 195
in food chains	940
inhalation of	958, 1015
in lactation	776, 780, 790, 793, 794
in man	938
metabolism	23, 65, 72, 170, 180, 181, 218, 227, 959
as radiocolloids	285
removal from body	1082, 1083,
1085, 1094, 1100, 1101, 1107, 1108, 1110, 1111	
toxicity of	959, 974, 982, 1034, 1039, 1051, 1067
Fixation, of calcium in bone	383, 385, 387,
389, 391, 392, 393, 394, 395, 396, 397, 398, 401, 406	
of lead in bone	389
Fluorine, on bone	837, 838, 839, 840, 841, 842, 847
bone histology	842
bone matrix	838, 839
in calcification	843, 844
and calcium metabolism	845, 846
effect on calcification	441
and fracture healing	433
and lathyrisms	847
and phosphorus metabolism	845
and teeth	515, 838, 840, 841, 844
Folic acid, against strontium leukemia	667
Food, analysis of	1126, 1154, 1159
calcium content	560
Food chain, fission products in	940
strontium in	146
Foods, cesium in	933
potassium ⁴⁰ in	933
Foodstuffs, phytic acid in	866
Formation constants, of complexes	283, 286
Fossils, calcium exchange in	390
strontium content	464, 476
Fracture, bone studies	325
Fracture healing (<i>see also</i> Bone healing)	
calcium uptake in	345, 357, 369, 374
fluorine and	433
phosphorus in	388
phosphorus uptake in	347, 374
plutonium uptake in	381
strontium and	433
strontium uptake in	381
sulfur uptake in	369
and vitamin A	599
and vitamin D	599
yttrium uptake in	369, 381
Frog, strontium* in	981
Function, of metals	74
Gargoylism, and calcium	168, 208
Gastrectomy, and mineral balance	894
Gastric acidity, and radiation	881
Gastric secretion, and vitamin D	626
Gland extracts, and bone growth	897, 898
Glucose, in the udder	802
Glycerophosphate, in teeth	504
Glycogen, and cartilage	895
Glycolysis, in calcification	439
in cartilage growth	414, 429, 430, 434
Goat, calcium in milk	769
lactation studies in	780, 812, 813, 817
parathyroids	707
strontium in	252, 816
strontium* studies in	969, 1020
Grafts, of bone	316, 317, 334
Graham's salt, and strontium	853
Grazing animals, and fallout	954
Great Britain, fallout in	913
Growth hormone, and bone	766
in rats	600, 601

*Radioactive.

	Item		Item
Growth hormone, and strontium	761	Insects, barium content	498
and sulfur	762	calcium content	186
Guinea pig, fission product studies	1082	radioisotope effects on	987
strontium in	609	strontium in	179, 498
strontium and Ca in	75, 81	strontium ⁸⁹ effects	1002
thyroid studies in	752a	Internal emitters (<i>see also</i> Radioisotopes)	
vitamin C studies	670	permissible levels	1013
Gypsum, as calcium source	849	Iodine ¹³¹ , in cattle and human thyroid	916
		in milk	916
Hair, calcium and P in	143	survey values	931
Hamster, calcium requirement	558	Ion exchange (<i>see also</i> Bone, calcium exchange in)	
teeth mineralization	499	for radioisotope removal	1100, 1104
Handbook, of biology	67	Ion exchange resins, and minerals	859
Haversian systems (<i>see also</i> Bone)		Iron, effect of bonemeal on	546, 547, 549
by calcium	365	intake in children	539
Hazard, from strontium ⁹⁰	932, 933, 934, 935, 937, 951, 952	Isotope dilution	1093
Health physics, general	57	of phosphorus	579
Heart contraction, and calcium	279	of strontium	545, 552, 555, 571, 582
Heavy elements, in bone	308, 309, 333	Kidney (<i>see also</i> Renal)	
Hen (<i>see also</i> Chicken)		analysis of, calcium in	238
calcium in blood of	523	decalcification	1121
calcium effect on	486	Lactation, and bone	540, 541
calcium exchange in	406	and calcium	377,
calcium metabolism in	521,	773, 778, 795, 796, 797, 810, 812, 815, 817, 818, 819	
524, 526, 529, 530, 531, 534, 535		fission products in	680, 776, 790, 793, 794
effect of Ca ⁴⁵	528	and minerals	794, 798
effect of P ³²	528	and parathyroid	701, 718
mineral depletion in	532, 533, 535	and phosphorus	774, 794, 819
phosphorus exchange in	406	physiology of	809
phosphorus metabolism in	524, 526, 529, 530, 534	Lactoglobulin, calcium binding of	908
radiation effects on	528	Lactose, and calcium, Sr absorption	141
tissue composition	518	from mammary gland	779
vitamin D effect on	486, 616	Lanthanum, metabolism of	188
Histochemistry, of bone	482	Lathyrism, and fluorine	847
of calcification	426	Lead, in bone	319, 389
fluorine in bone	839	in bone metabolism	370
of irradiated bone	970	calcium on removal	578
of parathyroids	680b	and EDTA	861
of vitamin D	593	phosphorus on removal	578
Histogenesis, of bone	415	vitamin D on removal	578
Histology (<i>see also</i> Pathology)		Leukemia	1050
and fluorine	842	from radiation	946
of radiation	965, 994, 995	and radioisotopes	1058
of strontium rickets	459	Limestone, strontium content	476
of teeth	499	Liver, calcium in	267, 538, 832
in vitamin D studies	615	minerals in	178
Hormone studies, in dog	745	Liver function, radiation effects on	1064
in mouse	730	Lung, radium from	193
in rat	721,	Lymphoid tissue, and calcium	890
722, 727, 729, 734, 739, 740, 741, 742, 744, 748		Lysine, and calcification	892
in sheep	737	and calcium absorption	905
Hormones, on blood minerals	689	and calcium, Sr absorption	141
and bone growth	673, 677, 763	Magnesium, analysis for	1127,
and bone metabolism	746	1130, 1137, 1138, 1154, 1156, 1161	
and calcification	418	in blood	852
and calcium fixation	677	in calcification	441, 442
and fat	738	in cattle	661
in man	728, 731, 733, 738	in cerebrospinal fluid	262
and metals	675	complexes	276, 1078
and minerals	675	and EDTA	107b
parathyroid	688	and phytates	857
and protein	738, 747	renal excretion of	852
tumor studies	678	Mammary gland, composition of	786, 787, 788
Horse, calcium in bone of	466	enzymes in	821
calcium studies in	891	fat synthesis in	805
phosphorus in bone of	466	and lactose	779
Hydration shell. (<i>See</i> Surface chemistry.)		metabolism of	801, 802, 821
Hypercalcemia	373	Man, absorption of Ca	107, 109, 110, 113, 119, 126, 155
Hypophyseal hormone, assay for	760	barium content	485
Hypophysectomy, and phosphorus	765	bone composition	581
and strontium	764	bone density in	583
Hypophysis, bone and protein	759	bone growth	348
and calcium metabolism	758	bone pathology	474
		bone studies in	896
Inhalation, of fission products	958, 1015	calcium in	168, 169, 194,
of strontium ⁹⁰	976	205, 206, 207, 208, 214, 217, 238, 241, 242, 255	
Inhibition, of calcification	420, 441, 442, 444, 884		
Injury. (<i>See</i> Toxicity.)			

	Item
Man, calcium metabolism in	542,
557, 559, 753, 848, 850, 851, 857, 964	
calcium and P absorption	155
calcium and P supplements	154
calcium and Sr absorption	126
calcium utilization in	557, 559
composition of	469, 487, 488, 489, 490
EDTA, studies in	1073, 1086, 1113, 1115, 1116
fallout effects	956, 957, 977
fission products in	938
hormone studies	728, 731, 733, 738
iodine ¹³¹ , in thyroid of	916
mineral studies	894
nutritional intake	539
parathyroids	680b, 694
phosphorus in bone exchange	388
potassium in	933
pregnancy studies in	788
radioactivity in	915, 933, 938, 955
radium in	193
radium metabolism in	964,
1031, 1043, 1044, 1055, 1056, 1057	
radium and Th in	232, 235
rickets in	594
skin transport	203
strontium adjuvant	456
strontium and barium content	485
strontium and Ca in	77, 80, 81, 82, 84, 98, 100, 101
strontium content	104, 465, 475, 485, 492
strontium metabolism in	219, 220, 233, 241, 243
strontium ⁹⁰ in	942, 943, 945, 949, 976
teeth metabolism in	511
tumor studies in	678
vitamin D in infancy	655
vitamin D studies	639, 659
Manganese, in teeth	509
Marine organisms (<i>see also</i> Fish)	
strontium and Ca in	103
Meat and calcium absorption	120
Mechanisms, of calcification	416,
436, 440, 441, 443, 444, 445, 446, 447	
of parathyroid	681a,
685, 688, 690, 691, 706, 707, 708, 710, 711, 713, 714	
of vitamin D	625, 637
Medicine, autoradiography in	9
minerals in	46
physics in	44
radioisotopes in	3, 33
Metabolism, of actinide elements	23
of boron	175
of calcium	22,
31, 34, 62, 110, 116, 117, 118, 127, 138, 147, 148,	
167, 168, 169, 194, 205, 206, 207, 208, 212, 213,	
214, 216, 217, 221, 222, 223, 237, 238, 241, 242,	
244, 247, 254, 255, 258, 289, 293, 294, 295, 300,	
311, 312, 330, 964, 998.	
calcium in cows	796
calcium in shells	224
of chloride	902
citrate effect on	854, 860
of EDTA	1071
of fission products	23,
65, 72, 170, 180, 181, 218, 227, 959	
general	2, 38
lanthanum	188
of mammary gland	801, 802, 821
mineral	12, 13, 14, 15, 21, 71
of phosphorus	22, 128, 131
of plutonium	227
of radioisotopes	40, 65, 236, 963, 1012, 1022
radioisotopes in	32, 38, 51
of radium	235, 253, 964, 998
standard values	2
of strontium	171,
173, 174, 175, 204, 219, 220, 225, 226, 228, 230,	
231, 233, 240, 241, 243, 245, 246, 249, 251, 252,	
256, 257.	
of yttrium	188, 200, 228

	Item
Metals, biological function	74
and hormones	675
and proteins	74
toxicity of	973
Mice. (<i>See</i> Mouse.)	
Microradiography, of bone	366, 495
of teeth	612
Milk (<i>see also</i> Lactation)	
amino acids into	800
analysis of	1126, 1138, 1159
calcium into	769, 791, 794
calcium content	781
and calcium, Sr absorption	126
and calcium in tissues	870, 873
composition of	804, 810, 822
iodine ¹³¹ in	916
phosphorus into	791, 813
phosphorus content	781
protein and, production	792
radioactivity in	806
removal of calcium* from	1105
removal of strontium* from	1105
strontium in	780, 782, 794, 822
sulfur into	800
Milk fever, effect of Ca	543
effect of P	543
and vitamin D	778
Mineral metabolism, brain function and	510
and estrogens	728
Mineralization (<i>see also</i> Calcification)	
of teeth	499
Minerals, biological function	71, 74
and blood complexes	275, 290
body transport	177
of bone	56, 61, 68, 69, 73, 460, 497
and cardiovascular system	618
in cartilage	460
in connective tissue	261
deficiencies and bone growth	550
depletion in hen	532, 533, 535
diet of man	539
effect on bone density	583
effect on muscle	272
in eggs	518
and gastrectomy	894
in hen tissues	518
and hormones	675
ion exchange resins	859
and lactation	794, 798
in liver	178
metabolism of	12, 13, 14, 15, 21, 46, 71, 74
nutrition	7, 71
and phytates	855, 857, 866
and pregnancy	784
resin action on	1072, 1104
in rickets	594, 596, 613, 634, 638, 640, 646, 647, 659
skin transport	201, 202, 203
and vitamin A	669
and vitamin D ₂	658
Mink, bone growth in	537
Mobilization, of calcium	693, 697
of minerals from bone	532, 533, 535
Mollusks, calcification in	163, 411
strontium in	176
Molybdenum, effect of high Ca diet	536
and pregnancy	811
Monkey, calcium in	255
strontium in	173, 256, 257, 314
strontium ⁹⁰ studies in	978, 979, 980, 1024
tooth studies	331, 332
Mouse, age studies	832, 834
bone growth	584
bone studies in	668
calcium in	75, 81, 93, 221, 222, 223
calcium metabolism	752b, 755
fission product studies	170, 975, 1090, 1091
hormone studies	730

*Radioactive.

	Item		Item
Mouse, pregnancy studies	785, 799	Parathyroids, and teeth	692
radiation studies	1025, 1026, 1028, 1029, 1030, 1033	and vitamin D	603, 611, 629, 655, 657
strontium in	204	Parotid gland, composition of extract	898
strontium and Ca in	75, 81, 93	Parturient paresis, and calcium	768, 772, 775, 820
strontium ⁸⁹ toxicity	961,	and parathyroid	709
962, 983, 988, 1029, 1030, 1041		and vitamin D	627
strontium ⁹⁰ studies in	984, 1029, 1030, 1052, 1054	Parturition, studies of	770, 771
teeth metabolism	512	Pathology (<i>see also</i> Histology)	
yttrium in	200	in bone	1036, 1038, 1053, 1069, 1070
Mucopolysaccharides, calcium and	300	in bone of man	474
Muscle, calcium in	268, 270	in calcification	426
calcium and Sr in	278	Pelecypod, calcium in	196
effect of minerals	272	Penicillin, on calcium	867
Muskrat, osteogenic sarcoma in	1048	Peritoneal lavage	714
Mycotoxicosis, on bone	889	Permeability. (<i>See</i> Transport.)	
Nephrectomy, and parathyroid	683, 684, 714	Permissible levels, internal emitters	1013
Nerve. (<i>See</i> Axons.)		Pharmacology. (<i>See</i> Toxicity.)	
Niacin, effect on blood Ca	671	Phosphatase, in rickets	638
Norway, fallout in	909, 910, 911, 912	in strontium rickets	458
Nuclear chemistry, general	19, 64	and vitamin D	605, 638
Nuclear science, general	6, 18, 20, 43, 60, 64	Phosphate compounds, complexes of	287, 288
Nutrition, general	2, 38	Phosphate solubilities, and calcification	421
mineral	7, 12, 13, 14, 15, 21, 71	Phosphopeptides, in calcification	640, 649
radioisotopes in	32, 38, 51	on calcium absorption	133, 134
standard values	2	Phosphorus, absorption	131, 135, 136, 137
Observed ratios, strontium and Ca	75,	and age	824
78, 80, 81, 82, 83, 84, 85, 100, 101, 105, 106		in blood	478, 823
Oceanography, and radiation	52	in bone	301,
and radioactivity	950	318, 326, 344, 346, 348, 350, 351, 358, 428a, 428b	
Oral tissues, and radiation	1037	bone exchange of	388, 397, 406
radiobiology of	971	in bone grafts	317
Organic acids, in bone	477	in bone of horse	466
Organic composition, of bone	460	and calciferol	595
of cartilage	460	in cartilage	430, 431
Ossification. (<i>See</i> Bone, Calcification.)		into casein	813, 814
Osteogenic sarcoma (<i>see also</i> Toxicity)		and corticoids	748
development of	1059	effects, on bone growth	537, 579
Osteolysis. (<i>See</i> Decalcification.)		of excess	574
Osteomalacia, and Ca fate	214, 234	of high Ca diet	536, 554
Osteoporosis, by phosphorus	351	on iron	546, 547, 549
strontium effect on	435	on lead removal	578
Parakeratosis	886, 893	of low levels	575
Parathormone (<i>see also</i> Parathyroids)		on Sr uptake	562, 570
and strontium*	1084	on teeth	515
Parathyroids, assay for	681c, 701	of vitamin D	590, 591, 610, 630
and bone	686, 695, 696, 697, 711, 712, 713, 720	in eggs	524, 526, 529, 530, 534
and calciferol	692	into erythrocytes	888
in calcification	418	and estrogens	735
and calcium in blood	523	and fat	868, 903
calcium metabolism	680a, 680c, 681b, 683,	in fish	125
684, 685, 687, 691, 693, 694, 698, 699, 700, 701,		and fluorine	845
702, 703, 704, 705, 710, 712, 713, 716, 717, 720		in fracture healing	347, 374, 388
and citric acid	683, 684, 711, 712	and hypophysectomy	765
composition of	705	intake in children	539
effect on Pu	341	isotope dilution of	579
and estradiol	699	and lactation	774, 794, 819
histochemistry	680b	metabolism	22, 128, 131
hormones	688	metabolism in hen	524, 526, 529, 530, 534
and lactation	701, 718	into milk	791, 813
mechanism of	681a,	milk content	781
683, 688, 690, 691, 706, 707, 708, 710, 711, 713, 714		and milk fever	543
and nephrectomy	683, 684, 714	in mollusks	163
phosphorus metabolism	682,	in osteoporosis	351
687, 693, 694, 701, 702, 703, 716		and parathyroid	682,
and renal function	716	687, 693, 694, 701, 702, 703, 716	
strontium metabolism	680c, 719	and radiation	1025, 1026
studies, in cat	682	requirements	143, 153, 154, 155, 156, 157
in cattle	708, 709	in rickets	596, 613, 634, 640, 646, 647, 657, 659, 660
in chicken	704	in teeth	501, 504, 507, 510, 511
in dog	689, 697, 700	and temperature	901
in man	680b, 694	and vitamin B ₁	587
in rabbit	682, 695	Phosphorus ³² , determination of specific activity	1122
in rat	680c, 681b, 681c, 685, 698, 699, 701, 706,	effect of diet on	579
710, 711, 712, 713, 714, 715, 716, 717, 719		effect on hens	528
sulfur metabolism	681b	Phosphorylation, and Ca	267

*Radioactive.

	Item		Item
Physiology, of bone	8,	Radiation, dosimetry	26, 53
of calcium	36, 47, 49, 50, 54, 55, 56, 63, 68, 69, 73, 323	effects of	1, 5, 39, 45, 53, 57, 66, 70, 528, 991, 1007
of lactation	117, 142	and gastric acidity	881
minerals in	809	histology of	965, 994, 995
12, 13, 14, 21, 46, 71, 74		and leukemia	946
Phytase, and vitamin D	664	and liver function	1064
Phytases, and calcium	848, 849, 850, 851, 857, 862	in medicine	3, 33
and magnesium	857	of oral tissues	1037
and minerals	855, 857, 866	on phosphorus metabolism	1025, 1026
Phytic acid, in foodstuffs	866	protection from	966
Pig, bone studies in	356	on sperm	1068
calcium and P absorption	135, 136, 137	and splenectomy	988
fluorine studies in	837, 838, 839, 842	teeth effects	1006
parakeratosis in	886, 893	Radiation biology, general	1, 30, 45, 53, 57, 66, 70
pregnancy studies in	811	Radioactivation analysis. (See Activation analysis.)	
Pituitary hormone, effect on teeth	515	Radioactivity (see also specific radioisotope)	
Placenta, strontium and Ca across	85, 106	and fisheries	950
Placental transfer. (See Pregnancy.)		in man	915, 933, 938, 955
Plants, minerals in	7	in milk	806
strontium and Ca in	81	and oceanography	950
Plasma. (See Blood.)		in thyroid	931
Platelets, calcium in	280	Radioautography. (See Autoradiography.)	
Plutonium, absorption	115	Radiobiochemistry, general	4, 24, 25, 37
in bone	333, 335, 341	Radiobiology, of oral tissues	971
and EDTA	1118	Radiochemistry	19, 64
in fracture healing	381	Radiocolloids, of fission products	285
metabolism	227	Radioisotopes (see also specific radioisotope)	
and pregnancy	785	bioassay	1014
and zirconium	1118	in biology and agriculture	11, 24, 25, 32, 37, 51
Polonium, and BAL	1087	in bone	304,
Polyphosphates, effect on Ca	563	310, 323, 325, 331, 332, 334, 337, 339, 1012	
Potassium, analysis for	1130, 1140, 1148	for bone-growth studies	356, 362
in blood	461	and bone strength	364
in man	933	dosimetry of	997
and testosterone	733, 745	and EDTA	1081
Potassium ⁴⁰ , in foods	933	effect on insects	987
Poultry. (See Chick, Hen.)		exchange into bone	397
Pregnancy, and bone	540, 541	and leukemia	1058
and calcium	377,	in medicine	3, 33
773, 777, 783, 788, 795, 799, 803, 811, 819		metabolism of	40, 65, 236, 963, 1012, 1022
and minerals	784	in mineral studies	11,
and molybdenum	811	12, 13, 14, 24, 25, 32, 37, 46, 51, 71	
and plutonium	785	in mollusks	411
and strontium	785, 799	in nutrition	32, 38, 51
Protection, from radiation	966	permeability to	177
Protein, and bone growth	550, 882	permissible levels	1013
calcium binding	260, 269, 271, 274	in rickets	652
dietary supplements	577	synergistic action	985, 986, 1011
and hormones	738, 747	in teeth	331, 332
and hypophysis	759	in teeth studies	513
and metals	74	toxicity of	959,
and milk production	792	963, 968, 982, 985, 986, 1018, 1022, 1031, 1034,	
strontium* effect on plasma	969	1037, 1039, 1045, 1047, 1052, 1054, 1062, 1063.	
and vitamin D	597	toxicology of	65
Rabbit, blood studies in	888	Radium, behavior of daughters of	384
bone studies in	673, 897	in bone	340, 341, 342
calcification in	427	and calcium	76, 102, 244, 295
calcium absorption by	126	excretion of	232, 235
calcium exchange in	383, 385	in man	193
calcium studies in	295, 296, 297, 890	metabolism of	235, 253, 964, 998
calcium supplements	145, 158	and strontium	245
Haversian systems in	365	and strontium, Ca	92
lactation studies in	819	toxicity of	996,
niacin studies in	819	1017, 1033, 1043, 1044, 1055, 1056, 1057	
parathyroid	682, 695	and vitamin D	628
phosphorus in bone of	318	Radon, in bone	384
pregnancy studies	819	Rare earths, biological mechanisms	360
radium in	295	in bone	160
strontium in	204, 226, 228, 231, 251, 315	Rat, age studies	825, 826, 827, 828, 831, 833, 835, 836
strontium and Ca in	75, 91, 106	barium, and Ca in	79
strontium ⁸⁹ toxicity	961, 962	blood minerals	461
strontium ⁹⁰ studies in	1004, 1005	bone, clearance	361
yttrium in	228	composition	566
Radiation, and alkaline phosphatase	1028	deposition	160
biological effects	887, 1065	growth	343,
bone effects	1023, 1027, 1033, 1034, 1036,	344, 345, 346, 347, 376, 377, 378, 382, 550,	
1038, 1039, 1041, 1055, 1056, 1057, 1059, 1063		576, 614, 645, 654, 663.	
*Radioactive.		histochemistry	482

	Item		Item
Rat, bone, histology.....	580	Resins, mineral removal by.....	1072, 1104
studies.....	763, 764, 765, 869, 873	Riboflavin, and bone growth.....	619
boron in.....	175	Rice, and calcification.....	633
calcium, in bone of.....	311, 312, 326	Rickets, and age.....	836
bone exchange.....	387	alkaline phosphatase in.....	594, 608, 646, 647
metabolism.....	162,	blood minerals.....	594, 646, 647, 657
167, 209, 213, 255, 265, 291, 544, 553, 554,		and bone growth.....	350
561, 563, 569, 773, 783, 907, 1080.		calcification in.....	438
and phosphorus supplements.....	141,	and calcium.....	665a
149, 150, 151, 551, 553, 554		and calcium fate.....	213
requirement.....	558	and dietary citrate.....	854, 860
calculi in.....	575	effect, of calciferol.....	595
caries in.....	502	of phosphorus in bone.....	428a, 428b
cartilage studies in.....	409, 410	of strontium.....	449
complexing agents in.....	853, 854, 859, 860, 863	on strontium.....	225
dietary studies in.....	849,	fixation of strontium in.....	565
868, 870, 873, 874, 882, 885, 903, 904, 905		and phosphatase.....	638
EDTA studies in.....	1112	phosphorus metabolism in.....	596,
effect of low calcium diet.....	538, 556, 569	613, 634, 640, 646, 647, 657, 659, 660	
fission-product studies in.....	180,	radioisotopes in.....	652
181, 218, 227, 308, 972, 1015		resistant.....	621, 657, 659
fluorine studies in.....	840, 841, 844, 845, 846, 847	by strontium.....	450, 451, 453, 454, 455, 457, 458, 567
fracture healing.....	599	strontium and Ca in.....	620
and growth hormone.....	600, 601	Rocks, analysis of.....	1150
hormone studies.....	721,	Roughage, antivitamin D.....	666
722, 727, 729, 734, 739, 740, 741, 742, 744, 748			
inhalation studies.....	958, 1015	Saliva, in teeth metabolism.....	500
iron metabolism in.....	546, 547, 549	Salivary glands, calcium in.....	172, 265
lactation studies in.....	786, 787, 788	and thyroid.....	756, 757
lead removal from.....	578	Sarcoidosis, bone in.....	896
mineral studies in.....	901	Sarcoma. (See Toxicity.)	
parathyroid.....	680c, 681b, 681c, 685, 698, 699,	Scurvy, trace elements in.....	670
701, 706, 710, 711, 712, 713, 714, 715, 716, 717, 719		Sea water, strontium content.....	481
phosphorus absorption.....	131	Serum (see also Blood)	
phosphorus in bone of.....	301, 326, 428a, 428b	analysis of.....	1130, 1139, 1147, 1156, 1158
phosphorus metabolism.....	536, 554	Serum albumin, mineral complexes with.....	290
plutonium in.....	227	Sheep, blood composition.....	478
radioisotope studies in.....	1011, 1037, 1049	bone density in.....	472
radium in.....	341	effect of calcium on bones.....	540, 541
radium toxicity.....	996	hormone studies.....	737
strontium absorption.....	111, 121, 122, 126, 130, 141	lactation studies on.....	823
absorption in skin.....	189, 190, 191, 192	Shell organisms, strontium and Ca in.....	103
in bone.....	299, 302, 303, 329	Shells, calcium in.....	224, 448
and calcium in.....	75,	calcium and P in.....	163
78, 81, 82, 83, 85, 88, 91, 92, 105, 106		strontium content.....	463, 481, 491
metabolism in.....	175, 204, 225, 545,	X-ray diffraction of.....	481
552, 555, 570, 571, 582, 620, 1075, 1080, 1117		Sialoadenectomy, and calcium metabolism.....	752b,
rickets in.....	450, 451, 453, 454, 455	755, 766	
strontium ⁸⁹ toxicity.....	961, 962, 1049	Skeleton. (See Bone.)	
strontium ⁹⁰ toxicity.....	960, 994, 995, 1008, 1009, 1036	Skin, calcium in.....	162
thyroid studies in.....	751, 754, 766	strontium absorption by.....	189, 190, 191, 192
tooth studies in.....	422, 499, 503, 504, 508	transport in.....	201, 202, 203
vitamin A studies.....	669	Sodium, and age.....	826
vitamin C studies.....	670	analysis for.....	1124, 1130, 1140, 1148
vitamin D effects.....	585,	in blood.....	461
588, 600, 601, 602, 604, 605, 607, 610, 614, 620,		bone exchange of.....	386
622, 623, 626, 628, 633, 635, 645.		calcium antagonism.....	279
Recrystallization. (See Bone, calcium exchange in.)		Soft tissues, calcium in.....	162
Region, effect on Sr content of human bones.....	492	Soils, analysis of.....	1144, 1159
Relative biological efficiency, of internal emitters.....	982	strontium and Ca in.....	81
of X- and beta rays.....	990	Solubility, of bone.....	480
Remineralization. (See Calcification.)		Somatotrophic hormone. (See Growth hormone.)	
Removal, of calcium* from body.....	1099, 1117, 1119	Sperm, radiation effects on.....	1068
of fission products.....	1082, 1083,	Spinal fluid, analysis of.....	1161
1085, 1094, 1100, 1101, 1107, 1108, 1110, 1111		Spleen, and calcium metabolism.....	680a
of strontium* from body.....	556,	Splenectomy, and radiation effects.....	988
1084, 1097, 1098, 1101, 1114, 1115, 1117		Stability, of complexes.....	283, 284, 286, 287, 288
Renal excretion, of calcium.....	209,	Strength, of bone.....	484
211, 216, 234, 237, 238, 241, 242, 244, 247, 255, 258,		Strontium, absorption.....	111,
852.		121, 122, 126, 130, 141, 142, 816	
of magnesium.....	852	activation analysis.....	220
Renal function, calcium effects on.....	247, 258	and adrenalectomy.....	764
and EDTA.....	1109	amino acids and absorption.....	141
parathyroid and.....	716	and ammonium chloride.....	1084
strontium effects on.....	215, 233, 241	analysis for.....	914, 1123,
Repair, of bone.....	483	1126, 1129, 1131, 1132, 1133, 1134, 1135, 1136,	
Requirements, for calcium.....	119, 143, 558	1141, 1144, 1145, 1146, 1150, 1157, 1159, 1160	
for phosphorus.....	143, 153, 154, 155, 156, 157	availability of.....	146

*Radioactive.

	Item
Strontium, and BAL	1091
in bone	17, 89, 90, 226, 299, 302, 303, 305, 306, 313, 314, 315, 319, 320, 321, 324, 327, 329, 335, 356, 363, 462, 475, 485, 492
composition	1016
fracture	989
graft studies	371
growth	944
pathology	380, 994, 995, 1008, 1009, 1048, 1052, 1054
in calcification	442, 444
and calcium, in bile	86, 89
comparison	75, 77, 78, 80, 81, 82, 83, 84, 85, 88, 91, 93, 98, 100, 101, 105, 106, 516
excretion effects	243
in fetus	85, 106
in fish	94, 95, 96, 108
function	452
in shells	103
supplements	456
transport	97
in cartilage	328, 424, 425
in chick	139, 142
and citrate	853, 864, 1080, 1084
complexes	283, 284, 286
and cortisone	680c
daughter behavior of	384
dosimetry of	1004
and EDTA	1075, 1082, 1090, 1115
effect, of age	225, 228
on calcification	422
of calcium in diet	562, 570, 582
of carriers	545, 552, 570, 571, 582
of complexing agents on	853, 864
in eggs	516
on eye	87
of phosphorus in diet	562, 570
of rickets	225, 565
of stable strontium	552, 555, 571
on teeth	512, 514, 515
and ergosterol	609
in fish	165, 166, 182, 183, 185, 248, 250, 914
fixation in bone	400
fixation in rickets	565
in food chain	146
in fossils	464, 476
in fracture healing	381, 433
in the frog	981
geochemical distribution	494
and Graham's salt	853
and growth hormone	761
hazard from	932, 935, 937, 951, 952
history of	58, 59
and hypophysectomy	764
inhalation of	976
in insects	179, 498, 1002
isotopic dilution and, retention	545, 552, 555, 571, 582
leukemia and folic acid	667
in limestone	476
and low mineral diet	1077
in man	465, 475, 485, 492, 942, 943, 945, 949
metabolism of	171, 173, 174, 175, 204, 219, 220, 225, 226, 228, 230, 233, 240, 241, 243, 245, 246, 249, 251, 252, 256, 257
in milk	780, 782, 794, 822
milk and, absorption	126, 130
in mollusks	176
in monkeys	173
in muscle	278
in osteoporosis	435
and parathormone	1084
and parathyroid	680c, 719
and plasma proteins	969
and pregnancy	785, 799
and radium	245
and radium, Ca	92
reduction of uptake	1096, 1104

	Item
Strontium, regional effects on bone content of	492
removal, from body	556, 1084, 1097, 1098, 1101, 1114, 1115, 1117
from milk	1105
from water	1106
renal function	215, 233, 241, 243
and rickets	450, 451, 453, 454, 455, 457, 458, 459, 567
in sea water	481
in shells	463, 481, 491
skin absorption of	189, 190, 191, 192
stable	80, 81, 104, 320, 321, 1089
surveys	913, 917, 918, 919, 920, 921b, 922, 923, 924, 925, 926, 927
in teeth	509
therapy with	1060, 1061
toxicity of	960, 961, 962, 973, 976, 978, 979, 980, 983, 984, 988, 990, 992, 994, 995, 999, 1001, 1003, 1005, 1008, 1009, 1020, 1024, 1029, 1030, 1032, 1035, 1036, 1041, 1048, 1049, 1053, 1066
transport	122, 139, 142
vitamin B ₁ effect	587
vitamin D	620
in worms	264
and zirconium	864
Structure, of bone	36, 49, 56, 61, 68, 73, 359, 384, 399, 493, 495
of bone mineral	399, 402, 403, 404
of cartilage	354
Sugars, and calcium absorption	872, 874, 877, 878, 879
Sulfur, in bone	837
bone exchange of	397
in bone-growth studies	366, 367, 368
in cartilage	336, 762
effect of vitamin D	592, 610, 612
and estrogens	729
in fracture healing	369
and growth hormone	762
into milk	800
and parathyroids	681b
Sulfur ³⁵ , bone effects of	1010
Sunshine project	941, 953
Supplements, of calcium and P	144, 156, 158
calcium, by rectum	145
Surface chemistry, of bone	402, 403, 404, 405, 407, 408
Surfaces, in bone metabolism	402, 403, 404, 405, 407, 408
Surveys, for cesium	913, 933
for fallout	909, 910, 911, 912, 913, 917, 918, 919, 920, 921a, 921b, 922, 923, 924, 925, 926, 927, 929, 930
for strontium	913, 917, 918, 919, 920, 921a, 921b, 922, 923, 924, 925, 926, 927
Synergism, of radioisotope effect	986, 1011
Tantalum, toxicity of	973
Techniques, autoradiography	9
of peritoneal lavage	714
in radiobiochemistry	4, 11, 24, 25, 37
radioisotope	11, 24, 25, 37
Teeth, autoradiography of	499, 505, 506
calcium in	312, 432, 499, 500, 501, 503, 505, 506, 508, 511
caries in	501, 502, 507
drug effects	883
effect of factors on	515
effect of strontium and Zn on	512, 514
electron microscopy of	471
and estrogens	744
and fluorine	838, 840, 841, 844
growth measurement	514
histology and chelation	1079
manganese function in	509
and parathyroids	692
phosphorus in	501, 504, 507, 510, 511
radiation effects on	1006
radioisotopes in	331, 332, 513
saliva and	500

Item	Item
Teeth, strontium function in	509
vitamin B ₁ deficiency	587
Temperature, and phosphorus	901
Testosterone, and calcium	733, 739, 745
and potassium	733, 745
Therapy, with calcium	289, 1060, 1061
with strontium*	1060, 1061
Thorium, in bone	340
complexing agents and	864
excretion	232
Thyroid, and bone	751, 752a, 753, 754
and calcium metabolism	753
function of, and calcification	418
iodine ¹³¹ from fallout in	916
radioactivity in	931
and salivary glands	757
Thyroxine, and calcification	722
Tissue culture, calcification studies in	419
strontium and calcium	90
Tissue distribution. (See Metabolism.)	
Tissue studies, with calcium	291
Tissues, analysis of	1122
Toad, calcium metabolism in	758
Tooth. (See Teeth.)	
Toxicity, of calcium ⁴⁵	992, 993, 1029, 1030, 1049
from fallout	975, 977, 1021
of fission products	959,
974, 982, 1034, 1039, 1051, 1067	
of metals	973
of radioisotopes	959,
963, 968, 982, 985, 986, 1018, 1022, 1031, 1034,	
1037, 1039, 1045, 1047, 1052, 1054, 1062, 1063	
of radium	996,
1017, 1033, 1043, 1044, 1055, 1056, 1057	
of strontium	973, 999
of strontium ⁹⁰	249, 961, 962, 983, 988, 992, 993,
1020, 1029, 1030, 1032, 1035, 1041, 1049, 1066	
of strontium ⁹⁰	960,
976, 978, 979, 980, 984, 990, 994, 995, 1001, 1003,	
1005, 1008, 1009, 1024, 1035, 1036, 1048, 1053	
of tantalum	973
of yttrium*	1053
of zirconium	973
Toxicology, of radioisotopes	65
Trace elements, activation analysis	1125, 1135
in animals	572, 573
in scurvy	670
Tracers, in mineral nutrition	7, 32, 38, 51
techniques	11, 24, 25, 37
Transport, of calcium in axons	199
of calcium and Sr	97
in skin	201, 202, 203
of strontium	122, 139, 142
Tricalcium phosphate, absorption of	144
Tumor studies, hormone effects	678
Tumors (see also Toxicity)	
calcium in	259
Turnover. (See Metabolism.)	
Udder. (See Mammary gland.)	
glucose in	802
Ultraviolet, and calcium	869
United Kingdom. (See Great Britain.)	
United States, fallout in	917, 918, 919, 920, 921a,
921b, 922, 923, 924, 925, 926, 927, 930, 931	
Uranium, in bone	292, 568
Urinary excretion, of calcium	263, 674
Urine, analysis of	1133, 1145
Utilization. (See Absorption, Availability.)	
Vascularity, of bone	375
Versene. (See Chelation, EDTA.)	
Vitamin A, in blood	478
effects of excess	669
and fracture healing	599
Vitamin B ₁ , and teeth	587
and Vitamin D	656
Vitamin B ₁₂ , and bone growth	619
Vitamin C, and bone fracture	668
Vitamin D, anti-vitamin factor	666
assay by P ³²	648
assay by Sr*	665b
blood minerals	655
and bone growth	614, 645, 654, 663
and calcium absorption	118,
616, 633, 635, 639, 641, 642, 643, 644, 645, 905	
and cardiovascular system	618
in cat studies	617
in cattle studies	628, 653
and citrogenase	607, 631
deficiency, calcium in	590, 635
phosphorus in	590
effect, on bone	592, 645, 654, 663
on bone growth	537
on calcium	598, 602, 612, 616, 620,
622, 623, 632, 635, 639, 641, 642, 643, 644, 645	
on citrate	585, 588, 603, 606, 607, 611, 631, 662
on energy	597
on lead removal	578
on phosphorus	590, 591, 610, 630
on protein	597
on strontium rickets	451
on sulfur	592, 610, 612
and ergocalciferol	604
and fracture healing	599
and gastric secretion	626
histochemistry of	593
histological studies	615
in infancy	655
in man	639, 659
massive doses	598, 627
mechanism of	625, 637
and milk fever	778
and parathyroids	603, 611, 629, 655, 657
and phosphatase	605, 638
and phytase	664
and radium	628
in rat studies	600, 601, 602, 604, 605, 607,
610, 614, 620, 622, 623, 626, 628, 633, 635, 645	
requirements for cattle	653
and strontium	620
and vitamin B ₁	656
Vitamin D ₂ , and minerals	658
Vitamins, on blood minerals	689
Waste disposal, in oceans	52
Water, analysis of	1123, 1129, 1144, 1145
effect on calcium	209
exchange of in bone	386
metabolism of	71
removal of strontium*	1106
Whole body counting	1146
Worldwide fallout	929
Worms, strontium in	264
X-ray absorptiometry, for analysis of bone	1132
X-ray diffraction, of bone	468
of lead in bone	319
of shells	481
of strontium in bone	319
X-rays (see also Radiation)	
in bone analysis	496
Yttrium, in bone	298, 335, 384
cortisone effect	676
and EDTA	1088, 1090
in fracture-healing studies	369, 381
metabolism of	188, 200, 228
Yttrium,* toxicity of	1053
Zinc, and calcium	886, 893
effect on teeth	512
Zirconium, and plutonium removal	1118
for radioisotope removal	1108
and strontium	864
toxicity of	973

*Radioactive.

AUTHOR INDEX

	Page		Page		Page
Abbott, O. D.	550	Axelrod, D. J.	304, 309, 1015	Blau, M.	107, 542
Abitbol, V.	721, 734	Axelrod-Heller, D.	160, 299	Blifford, I. H., Jr.	928
Abrams, R.	958	Ayyar, N. K.	855	Bliven, F. E., Jr.	388
Aird, R. B.	177	Azorin, E.	132, 145	Block, M. H.	667, 988
Alvazyan, L. A.	680a			Bloom, M. A.	1033
Akademiia Meditsinskikh		Babers, F. H.	1002	Bloom, W.	697, 965, 1033
Nauk S.S.S.R., Institute of		Bacigalupo, A.	798	Blosser, T. H.	768, 770, 771
Sanitation and Occupational		Backmann, R.	1122	Boche, R. D.	70
Disease.	959	Bacon, J. A.	649, 680c	Boda, J. M.	543, 772, 795, 796
Akademiia Nauk S.S.S.R.,		Badellino, F.	746, 765	Bodson, P.	391, 394, 395
Institut Genetiki.	1	Baginski, E. S.	1161	Boelter, M. D. D.	177, 773
Akagi, H.	89, 123, 124, 1090	Baisset, A.	722	Bogdasheva, A. V.	466
Akamatsu, M.	248	Bal, M. E. R.	577	Bogoroch, R.	332
Albaum, H. G.	439	Balasova, O. N.	154	Bois, P.	679, 748
Alberty, R. A.	288	Ballezo, H.	1123	Bonard, E. C.	263
Al'bitskii, B. A.	1121	Banks, E. M.	516	Bonati, F.	1071
Albright, F.	857	Baranova, E. F.	231, 1032	Bond, V. P.	915, 977
Albright, J. L.	768, 770	Barbera, R. C.	130, 320	Bonner, J. F., Jr.	824
Albritton, E. C.	2	Barbieri, E.	409, 410	Booker, D. V.	913
Alexander, G. V.	75, 130	Barnes, L. L.	817	Borjon, P.	674
Allara, E.	680b	Barron, E. S. G.	969	Boroughs, H.	108,
Allez, M.	878, 879	Bartels, E. D.	681a		164, 165, 166, 182, 187, 914
Amprino, R.	292, 338	Bassett, C. F.	537	Borovskii, E. V.	587
Anderegg, G.	287	Bassett, S. H.	205	Borrelli, P. L.	147
Anderson, E. B.	3	Bassir, O.	538	Bourne, G. H.	8
Anderson, E. C.	933, 944	Baud, C. A.	390	Bowie, E.	267
Anderson, M. A.	174	Bauer, G. C. H.	77, 78,	Bowman, D. K.	487
Anderson, W. A. D.	960,		79, 343, 344, 345, 346, 347, 348,	Boyd, D. W.	476
	1029, 1030		349, 350, 351, 352, 386, 387, 1124	Boyd, G. A.	9, 356
Ando, S.	898	Bauman, V.	161	Boyd, J. O.	388
Andreatta, C.	460	Bavetta, L. A.	751, 892	Boyle, A. J.	1147
Andreeva, O.	806	Baylor, C. H.	205	Boyne, A. W.	540, 541
Andrews, G. A.	3, 84	Beal, V. A.	539	Brace, C.	1010
Andrews, H. L.	43, 934	Beale, G. E.	586	Brammel, W. S.	893
Andrews, J. R.	1010	Beck, J. C.	1148	Breitling, G.	966
Anonymous.	848, 932	Beckerley, J. G.	6	Brine, C. L.	109, 207
Anthony, A.	461	Becks, H.	763, 882	Brochart, M.	143
Anthony, D.	204, 961, 962	Beeson, W. M.	803	Bronner, F.	110, 167, 168, 169,
Antoni, R.	293	Behrmann, V. G.	174		208, 255, 681b, 729, 850, 851
Appel, I.	266	Belanger, L. F.	162,	Brooksbank, W. A.	1125
Araki, M.	259		300, 368, 499, 837, 838, 839	Brothers, M.	100, 243
Archer, V. E.	232	Bellamy, A. W.	940	Brown, E.	155
Archibald, R. M.	729	Bellin, J.	206	Brown, E. B., Jr.	282
Argonne National Laboratory,		Bellin, S. A.	585, 662	Brown, W. O.	867
Biological and Medical Re-		Beloborodova, N. L.	231, 1032	Browne, J. S. L.	1148
search Division.	963	Benda, C. E.	168, 169, 208, 850, 851	Brownell, G. L.	26, 753
Armitage, P.	604	Benzie, D.	540, 541	Brucer, M.	3
Armstrong, W. D.	339, 720	Bere, L. R.	586	Brues, A. M.	967, 968, 983,
Arnold, J.	195	Berg, M.	1011		1007, 1034, 1041, 1051, 1057
Arnold, J. S.	76,	Berger, E.	243, 1113	Brull, L.	852
	102, 244, 253, 294, 295, 296, 297,	Bergh, H.	909, 910, 911, 912	Bryant, F. J.	80, 913, 1126
	298, 340, 341, 365, 383, 384, 385	Berlie, M. R.	521, 531	Buchanan, D. L.	969
Aronoff, S.	4	Bernick, S.	751	Buchanan, G. D.	716
Arrington, L. R.	536	Bernimolin, J.	852	Buckley, H. D.	327
Arvidsson, U. B.	581	Bertran, E. C.	525	Budy, A. M.	723, 744, 749, 750
Asano, M.	159	Bescel-Liversac, J.	336	Bugher, J. C.	935
Asari, T.	462, 463, 464, 465	Betzler, H.	202, 203	Burger, M.	437, 438, 439, 440, 578
Aschkenasy, A.	721, 734	Bevelander, G.	163, 411	Burgess, J.	326
Ashton, G. C.	561	Bharucha, R. P.	849	Burstone, M. S.	353, 970, 971
Asling, C. W.	160, 173, 299	Bhaskar, S. N.	744	Burykina, L. N.	972, 1035
Aten, A. H. W., Jr.	769	Biddulph, O.	7	Butler, J. A. V.	10
Atherton, D. R.	76, 102, 245, 246	Bisetti, A.	1102	Byers, T. E.	584
Atomic Bomb Casualty Com-		Biskis, B. O.	984	Bzhalava, A. N.	774
mission.	5	Björnerstedt, R.	17, 305		
Aub, J. C.	342, 370, 389, 964, 1031	Black, A. L.	38	Calhoun, D. W.	730
Aubert, J. P.	194	Blakely, J.	733	Calhoun, J. A.	370, 389

	Page		Page		Page
Calverley, C. E.	868	Connor, T. B.	445, 629, 665a, 691	Ducros, H.	891
Cameron, D. A.	354	Conrad, H. R.	598, 778	Duncan, C. W.	792
Campbell, C.	936	Cook, M. J.	487, 488, 489, 490	Duncombe, W. G.	779
Campbell, J. A.	546, 547, 549	Cooper, A. R.	469	Dunham, C. L.	977
Campbell, W. W.	177	Copp, D. H.	213,	Dupuis, Y.	876, 877, 878, 879, 880
Carey, M.	659		225, 227, 299, 304, 309, 313,	Durbin, P. W.	173
Carlsson, A.	78, 79, 346, 347, 348,		361, 381, 599, 825, 939, 1077	Dziewiatkowski, D. D.	610, 729
	349, 350, 351, 352, 386, 387, 544,	Corrigan, H.	753		
	588, 589, 590, 591, 592.	Cost, K.	439	Eaton, H. D.	797
Carlström, G.	775	Coune, F. L.	1076	Ebel-Gries, A.	739, 740
Carr, C. W.	260	Courvoisier, B.	263	Ebihara.	551
Carr, M. H.	1127	Coussens, R.	800	Eckelmann, W. R.	98, 943, 945, 1160
Carril, J. N.	687	Cowan, F. P.	976	Edgren, R. A.	730
Carroll, E. L.	857	Cramer, C.	825, 1077	Edington, G. M.	978, 979, 980
Carter, A. C.	435, 456	Cramer, J. W.	585,	Eggers-Lura, H.	1079
Cartier, P.	301, 412, 428a, 428b,		600, 601, 602, 854, 860	Egg-Larsen, N.	414
	429, 430	Crane, J. T.	654, 833	Egnund, K. M.	622
Cassarett, L. J.	277	Crawford, J. D.	603	Eichler, O.	266
Caster, W. O.	937	Cremer, H. D.	293, 564	Eisenbud, M.	27,
Castleman, B.	603	Cronkite, E. P.	977		28, 917, 922, 923, 924
Catchpole, H. R.	261	Crowder, H. M.	117, 148, 831	Ekman, L.	780
Catron, D. V.	561	Crowley, J.	1015	Eliassen, R.	1106
Catsch, A.	545, 853	Cruickshank, E. M.	604	Ellenberger, H. B.	781
Causeret, J.	144, 150, 209	Cucurachi, L.	1071	Eller, M. H.	46
Ceccaldi, P. F.	201	Curtis, H. J.	111	Elliott, J. R.	611, 683,
Chace, M. J.	309	Custer, J. H.	908		684, 711, 712, 713, 714, 1080
Chadwick, J.	64	Cuthbertson, E. M.	309	Ellis, C. D.	64
Chaikoff, I. L.	181, 302, 303	Czajka, D. M.	1040	Elving, P. J.	1131
Chamberlain, A. C.	80, 913, 1126			Emslie, A. R. G.	642
Chambon, Y.	724, 725, 726	Dagaeva, L. N.	500	Enders, A. C.	713, 714
Chauouat, Y.	677	D'Agostino Barbaro, A.	870	Engel, M. B.	261, 695
Chapman, D. G.	546, 547, 549	Dalgarno, A. C.	540, 541	Engfeldt, B.	305,
Chapman, W. H.	915, 938	Dallemagne, M. J.	390, 391,		358, 397, 612, 613, 685, 1038
Charles, M.	98		392, 393, 394, 395, 467, 732	Engstrom, A.	17,
Chauchard, P.	449, 451	Danil'chenko, O. P.	264		305, 358, 359, 468, 1038, 1132
Ch'en, J. S.	1072	Daughaday, W. H.	762	Entenman, C.	181, 302, 303
Chen, P. S., Jr.	210, 211, 1128	Davidson, W. L.	60	Erf, L. A.	782
Cherkaskii, L. A.	1036, 1037	Davies, B. M. A.	681c	Ericsson, Y.	501
Cherkasova, L. S.	668	Davis, B.	153	Ershoff, B.	751
Chiba, M.	503	Davis, G. K.	198, 528,	Ershova, O. A.	889
Chin, S.	593		529, 530, 536, 783, 811, 829	Evans, H. M.	763, 882
Chipman, W. A.	164	Davis, H. A.	597	Evans, R.	18
Chitul, W.	869	Davis, M. E.	728	Evans, R. D.	964, 1031
Chitre, R. G.	594	Davis, R.	713	Ezmirlian, F.	130,
Chojnacki, T.	262	Dawson, J.	682		319, 320, 321, 475, 562
Chow, T. J.	103, 1129	Dawson, K. B.	396		
Christie, J. H.	1011	Deane, B. C.	439	Fabry, C.	391, 392, 393, 394, 395, 467
Cicardo, V. H.	758, 840, 841	Debackere, M.	801	Falkenheim, M.	398
Claassen, V.	595, 596	De Bastiani, G.	752a	Farabee, L. B.	976, 1133
Clark, I.	727	De Lancie, M. F.	357	Fay, M.	174
Clarke, C. N.	1073	Delaville, M.	736	Feaster, J. P.	528, 783, 811
Clarke, N. E.	1073	De Lerner, S. J.	840, 841	Fedorova, A. D.	989
Clegg, R. E.	271	Della Monica, E. S.	908	Feldman, I.	407
Clemedson, C. J.	17, 305, 1038	De Loose, R.	800	Feng, Y. S. L.	752b, 755, 756, 757
Clement, D.	127, 128, 735, 736	De Luca, H. F.	605, 606, 860	Fenn, W. O.	268
Cochran, K. W.	973	Denson, J. R.	1130	Fentress, S. D.	488, 489, 490
Cofer, E. S.	728	Dentzer, G.	1078	Ferenc, S.	784
Cohen, J.	355, 457, 458, 479, 1100	Devis, R.	318	Ferrebee, J. W.	1155
Cohen, W. E.	974	de Vuyt, A.	15	Field, H., Jr.	903
Cohn, E. T.	621	Dewald, R. H.	494	Filatov, G. V.	812, 813
Cohn, S. H.	170,	Dewitte, R.	392	Finean, J. B.	468
	915, 938, 975, 1001, 1074, 1075	Diao, E.	557	Finkel, M. P.	785,
Cohn, W. E.	177, 621	Di Ferrante, N.	729		968, 981, 982, 983, 984, 1034,
Coid, C. R.	122, 776	Dikshit, P. K.	607, 608, 630, 631		1039, 1040, 1041, 1051.
Cole, H. H.	772	Diner, W. C.	603	Finkle, R.	204, 961
Cole, L. L.	142	DiPaolo, E.	672	Finlay, J. M.	214
Collins, R. A.	632	DiStefano, V.	413	Finstad, G.	909, 910, 911, 912
Colodzin, M.	232	Dolfini, G.	609	Fischer, E.	145
Colovos, N. F.	597	Dontenwill, W.	673	Fischer, F.	731
Comar, C. L.	11,	Doull, J.	973, 1018	Fischer, I.	1145
	12, 13, 14, 81, 82, 83, 84, 85,	Douste-Blazy, L.	722	Fisher, W.	1146
	99, 106, 116, 126, 141, 212, 254,	Drea, W. F.	518	Fisher, W. R.	933
	356, 382, 517, 520, 553, 582,	Dreisbach, R. H.	172, 265	Fishler, M. C.	181, 302, 303
	737, 777, 794, 803, 815, 818,	Driggers, J. C.	517,	Fitzgerald, P. J.	1042
	829, 830, 837, 838, 839, 842,		528, 529, 530, 1076	Flaschka, H.	1103, 1137
	905, 916, 1117.	Droz, B.	336	Flink, E. B.	282
Comel, M.	171	DuBois, K. P.	973, 1018	Floyd, R. L.	306
Conn, E. E.	285	Duckworth, J.	16, 540, 541	Flynn, R. J.	1040

	Page		Page		Page
Foland, J. M.	488, 489, 490	Greenbaum, A. L.	786, 787, 788	Heyn, C. B.	769
Foland, W. D.	487	Greenberg, D. M.	21,	Hiatt, H. H.	420, 424
Follis, R. H., Jr.	450	86, 177, 181, 269, 309, 599,		Hiatt, R. W.	108, 166, 182, 914
Fontaine, R.	739, 740	620, 621, 773, 1083, 1084.		Hibbs, J. W.	627, 778
Foran, R. F.	614, 654, 833	Greenberg, J.	542, 1113	Higginson, J.	474
Forbes, G. B.	826	Greulich, R. C.	368	Hightower, B. M.	120
Forbes, R. M.	175, 469	Gribetz, D.	603	Hill, R.	16, 540, 541
Foreman, H.	1081	Griswold, R. L.	178	Hiltbran, R. C.	628
Forni, I.	460	Grosch, D. S.	179, 987	Hindman, W. M.	1161
Forsander, O.	656	Groshev, M. K.	472	Hine, G. J.	26, 997
Fournier, P.	112, 872, 873, 874,	Gross, M.	789	Hiniker, J. J.	326
875, 876, 877, 878, 879, 880		Gross, W. J.	146, 552	Hinrichs, K.	87
Fox, B. W.	881	Grossman, M. I.	881	Hiramatsu, Y.	503, 504
Fox, H. M.	470	Grummer, R. H.	886	Hirvonen, L.	272
Fox, L.	363	Guelbenzu, M. D.	675	Hiyama, Y.	183, 185
Fradkin, G. E.	360	Guglielmi, G.	147	Hjertquist, S. O.	397, 685
Frandsen, A. M.	882	Guild, W.	1100	Hoard, A. G.	27, 28, 924
Frank, H. A.	1127	Gump, H.	1010	Hodel, E.	29
Frank, R.	471	Gunther, L.	621	Hodge, H. C.	277, 398, 400
Fraser, R.	214, 234	Gupta, O. P.	1112	Hodges, E.	104
Frau, F.	215	Gurian, J.	252, 816	Hodges, R. M.	475
Frederickson, J. M.	361	Gustafson, P. F.	193, 235	Hodgkin, A. L.	184
Freeman, S.	216,	Gutentag, J.	316	Hoecker, F. E.	310, 628, 1000, 1044
258, 611, 683, 684, 1072		Gutman, A. B.	417	Hoefer, J. A.	893
French, R. B.	550	Haag, J. R.	156	Hoekstra, W. G.	886
Fretter, V.	176	Haavaldsen, R.	622, 623	Hogan, A. G.	619
Freydberg-Lucas, V.	827, 828	Hagge, W.	689	Holasek, A.	1103
Friesay, M.	615	Hahn, R. B.	1134	Hollaender, A.	30
Fridenshtein, A. Y.	415	Hallinger, H. Z.	22	Hollingshaus, H.	364
Fried, J. F.	1097, 1098	Hamilton, J. G.	23,	Hollunger, G.	588
Friedell, H. L.	380, 985, 986, 1011	44, 114, 115, 160, 173, 180,		Holt, E. F.	246
Friedlander, G.	19	181, 218, 227, 299, 304, 307,		Holt, L. E., Jr.	421
Fuller, R. K.	170, 975	308, 309, 381, 825, 1015, 1085		Honour, A. J.	361
Fuse, S.	883	Hammarlund-Essler, E.	612	Horiguchi, K.	158
Gaetjen, J. E.	1160	Hanok, A.	442, 443, 444, 1156	Hori, S.	522
Gaillard, P. J.	686	Hansard, S. L.	116,	Howard, J. E.	31,
Gallagher, D. M.	964	117, 148, 212, 553, 554, 598,		445, 629, 665a, 690, 691	
Gallup, W. D.	153	680c, 778, 783, 803, 829, 830,		Huditz, F.	1137
Garagnani, A.	672	831.		Hudson, J. C.	389
Garcia, F. M.	687	Hanssler, H.	624	Huffman, C. F.	792
Gast, P. W.	104	Harbers, E.	1122	Hugot, D.	144, 150
Gasvoda, B.	969	Hardy, E. P., Jr.	918,	Hundeshagen, H.	1082
Gavett, E.	400	919, 920, 921a, 921b, 922, 923		Hunsaker, W.	704
Geissberger, W.	217	Harley, J. H.	27,	Hunt, H. B.	1045
Gensicke, F.	200	28, 917, 922, 923, 924		Hunzinger, W. A.	1086
Geoffroy, R. F.	727	Harris, A.	884	Hursh, J. B.	232, 1087
Gershoff, S. N.	616, 617	Harris, E. J.	270, 278	Hurst, P.	603
Geschickter, C. F.	138	Harris, L. E.	537	Ichikawa, R.	183, 185
Gest, J.	1019	Harris, N. O.	362	Ignatyev, A. I.	39, 991
Geyer, N.	1103	Harris, P. L.	665b	Ikeda, M.	551
Geyer, R. P.	267	Harris, R. S.	110,	Iin, D. I.	790
Gibson, J. G.	1003	168, 169, 208, 255, 850, 851		Imada, S.	151
Gilbert, C.	618	Harrison, G. E.	219,	International Conference on the	
Gilbert, D. L.	268	220, 555, 1135, 1136		Peaceful Uses of Atomic	
Gillingham, J. E.	584	Harrison, H. C.	118	Energy, Geneva, 1955.	32, 33, 887
Gillis, M. B.	632	Harrison, H. E.	118, 625, 856	Irving, J. T.	34, 422, 759, 844
Gillman, J.	618	Hart, H. E.	243	Isaksson, B.	134
Giraud, G.	674	Hartles, R. L.	502	Iseri, L. T.	1147
Gittleman, I. F.	655	Hartnett, C.	762	Ishio, S.	140, 250
Glasstone, S.	20	Hartsok, E. W.	885	Itano, M.	1147
Glidden, M. A.	113	Hasterlik, R. J.	1043, 1057	Ito, M.	159
Glover, D. M.	316	Hastrup, B.	731	Ito, Y.	311, 503, 504, 556
Goldberg, E. D.	187, 196	Hayami, H.	149	Ivy, A. C.	881
Goldenberg, H.	416, 441, 442, 843	Hegsted, D. M.	119, 616, 617	Jacobs, T.	519
Gong, J. K.	170, 915, 938, 975, 1075	Heimer, C. B.	418	Jacobsen, A. B.	216
Gordon, A. H.	681c, 688	Hein, R. E.	271	Jacobson, L.	181
Gordonoff, T.	401	Heite, H. J.	87	Jacobson, L. O.	667, 988, 1007, 1066
Goto, H.	89, 123, 124	Heller, J. H.	363	Jamieson, J. W. S.	643
Goto, T.	551, 658	Helmick, M. J.	88, 1099, 1100	Japan Society for the Promo-	
Goudal, H.	692	Hempelmann, L. H.	1031	tion of Science.	941
Gourley, D. R. H.	888	Henneman, P. H.	857	Jarabak, J. R.	312
Govaerts, J.	399, 519, 732, 802	Henrichsen, E.	419	Jeanmaire, L.	1104
Gowda, H. S. L.	855	Henry, K. M.	376, 377, 378, 379	Jee, W. S. S.	295, 296, 297, 365, 385
Graevskaia, B. M.	996	Herron, J. W.	190, 191	Jenkins, E. N.	1151
Grainger, R. B.	619	Herting, D. C.	585, 626, 663	Jenness, R.	1138
Graul, E. H.	1082	Heslep, J. M.	940	Jeter, M. A.	811
Grayzel, D. M.	418	Hevesy, G.	24, 25, 221, 222, 223, 473		

	Page
Jodrey, L. H.	224, 448
Johnson, K.	296, 297
Johnson, R. E.	797
Johnston, F. A.	109, 207, 557
Johnston, M. E.	173
Johnston, P. M.	520
Jolly, M.	35
Jonas, H.	888
Jones, C. H.	781
Jones, D. C.	225, 313, 825
Jones, H. G.	121, 122, 555, 682
Jones, I. R.	156
Joseph, N. R.	261, 273
Joshi, J. G.	607, 630, 631
Josiah Macy Jr. Foundation, Conference on Metabolic Inter- relations.	36
Jowsey, J.	226, 314, 315, 322, 382, 1088
Jowsey, J. R.	521
Judd, J. M.	978, 979, 980
Justin-Besancon, L.	692
Kabakow, B.	97, 1114
Kajdi, C. N.	421
Kalkstein, M. I.	1105
Kambe, Y.	883
Kamen, M. D.	37, 832
Kamins, M. M.	312
Kane, G. G.	558
Kanematsu, S.	559
Kapitsa, L. M.	989
Kaplan, M.	181
Kaplan, N.	1084
Karnofsky, D. A.	1046
Karpyseva, V. S.	154
Kau, G.	182
Kaufman, W. J.	1106
Kautz, G.	660
Kawin, B.	227, 676, 939, 1089
Kaylor, C. T.	105
Keane, K. W.	632
Keener, H. A.	597
Kehar, N. D.	855
Keitel, H. G.	733
Kelkar, M. K.	594
Kennedy, C.	868
Kennedy, J. W.	19
Kenny, A. D.	693
Kepes, A.	274
Kepp, R. K.	990
Keutmann, E. H.	205
Keynes, R. D.	184
Khadaide, L. L.	1047
Kibrick, A. C.	1139
Kidman, B.	228
Kiehn, C. L.	316
Kikuchi, T.	89, 123, 124, 1090
Kinersley, T.	505
King, R. C.	186
Kingsley, G. R.	1140
Kirman, B. H.	942
Kirpichnikov, V. S.	125, 229
Kisielewski, W. E.	92, 230, 324, 1091, 1092, 1141
Kitamura, H.	151
Klare, V.	869
Kleiber, M.	38, 791, 795, 796, 805
Klotz, H. P.	692
Kobayashi, K.	140, 250
Kodicek, E.	604
Kogan, A. M.	889
Kohno, T.	151
Kon, S. K.	376, 377, 378, 379
Konig, H.	363
Kono, T.	89, 123, 124, 560, 1090
Koopman-Van Eupen, J. H. M.	290
Kornberg, H. A.	1093

	Page
Kortkov, F. G.	39, 991
Kotake, Y.	152
Koyama, S.	810
Koyanagi, T.	633
Kozlovskii, V. S.	890
Kraintz, F. W.	715, 716, 717
Kraintz, L.	717
Kramer, B.	457, 458
Krane, S. M.	694, 753
Krasovskaia, S. P.	317
Kreplich, J.	208
Kreplick, J.	168
Krieger, C. H.	664
Kroll, H.	1094
Krumholz, L. A.	187, 1048
Krynauw, G. N.	1154
Kuhn, U. S. G. III.	916
Kulp, J. L.	104, 476, 492, 943, 945, 1160
Kumagai, T.	159
Kumamoto, Y.	506
Kumar, K. S. V. S.	814
Kurlyandskaya, E. B.	231
Kuyper, A. C.	477
Kuzma, J. F.	960, 992, 993, 1030, 1049
Kyker, G. C.	40
Kyoto University, Institute of Chemical Research.	41
LaChance, L. E.	179, 987
Lacroix, P.	42, 318, 366, 367
Laford, C. S.	577
Lagergren, C.	1132
Lane, W. B.	170, 975
Langham, W.	933, 944
Lansing, A. I.	832
Lapp, R. E.	43, 945
Laskin, D. M.	695
Lassiter, C. A.	792
Laszlo, D.	97, 98, 100, 101, 107, 188, 206, 241, 242, 243, 542, 1095, 1113, 1114, 1115, 1116.
Lathrop, K.	204, 961, 962
Laughlin, J. S.	1028
LaViolette, D.	327, 1009
Law, K. A. O'D.	328
Lawrence, B. J.	1149
Lawrence, J. H.	44, 380, 1050, 1058
Lawton, F. E.	502
Layani, F.	677, 734
Lea, D. E.	45
Lebedev, M. I.	466
Lebedinsky, A. V.	39, 793, 991
Leblond, C. P.	368, 506
Lecoq, R.	449, 451, 634
Leddycotte, G. W.	1125
Lee, J. A.	146
Lees, H.	477
Leikind, M. C.	46
Lemaire, R.	891
Lengemann, F. W.	85, 90, 106, 126, 794, 905
Leon, M. A.	275
Lestina, J.	984, 1040
Levy, A.	674
Lewin, I.	1116
Lewin, S.	1096
Lewis, A.	826
Lewis, E. B.	946
Lewis, P. K., Jr.	886
Li, C. H.	760
Libby, D. A.	858
Libby, W. F.	947, 948, 1105
Lichtwitz, A.	127, 128, 735, 736
Likins, R. C.	845, 846, 892
Liljekvist, J.	589

	Page
Lindenbaum, A.	286, 1097, 1098
Lindenblad, G. E.	1109
Lindquist, B.	78, 79, 348, 349, 350, 351, 352, 387, 635, 636, 637
Lindquist, M.	588, 589, 590, 591, 592
Lipatova, N. A.	819
Lisco, H.	968, 983, 1007, 1034, 1041, 1051
Lisenko, N. V.	507
Litovitz, T. A.	138
Littman, A.	881
Litvinov, N. N.	994, 995, 1052, 1053, 1054
Liu, C. H.	561
Loeffler, R. K.	189, 190, 191, 192
Loew, O.	452
Lofgreen, G. P.	38, 1142
Logan, M. A.	47
Löhr, H.	638
Lohr, W.	958
Long, T. A.	153
Lontie, P.	423
Looney, W. B.	232, 1055, 1056, 1057, 1099, 1100
Loosli, J. K.	817
Lorick, P. C.	91, 369
Lostroh, A. J.	760
Lotz, W. E.	356, 737, 837, 838, 839, 842
Louie, B. J.	160
Loutit, J. F.	949
Love, R. A.	976
Lovelace, F. E.	129
Loving, M.	789
Low-Beer, B. V. A.	380, 1058
Luecke, R. W.	893
Luick, J. R.	38, 791, 795, 796, 1142
Lund, L.	909, 910, 911, 912
Lundberg, B.	1132
Lusted, L. B.	654
Luttgau, H. C.	279
Lyke, W. A.	148
McArthur, C.	319, 475
McCall, J. T.	198, 528, 529, 530, 811
McCance, R. A.	233
McCarthy, A.	577
McCauley, R. F.	1106
McCay, C. M.	558, 849
McChesney, E. W.	859
McClendon, J. F.	847
McClure, F. J.	845, 846
McDaniel, K. K.	487, 488, 489, 490
McDonald, B. B.	155, 583
MacDonald, N. S.	75, 91, 130, 319, 320, 321, 334, 369, 475, 562, 1101.
McHardy, G. J. R.	131
Mackay, I. R.	738
McLean, F. C.	48, 49, 50, 580, 696, 697, 749, 750, 1143
McLean, R.	370, 389
MacLeod, F. L.	155, 583
Magnusson, T.	588, 590, 591, 592
Mahlman, H. A.	1125
Main, E. R.	568
Maioli, M.	894
Majno, G.	743
Makarycheva, R. I.	1059
Maletskos, C. J.	169, 355, 850, 851, 1099, 1100
Maneini, A. M.	673
Mandel, P.	739, 740
Manoilov, S. E.	996
Manunta, G.	698, 699, 741, 742
Maqsood, M.	99
Mariani, B.	1102
Marinelli, L. D.	193, 997

	Page
Marinoni, U.	371, 765
Marks, P. A.	420, 424, 425, 895
Marnay, C.	700, 705
Marolda, C. I.	132, 639
Marsh, H.	478
Marshall, J. H.	322, 355, 479
Martell, A. E.	276
Martell, E. A.	925, 926, 1144
Martin, E.	263, 743
Martin, R. P.	954
Martland, H. S.	1031
Marx, W.	761
Maslow, H.	418
Massa, G.	746
Massachusetts Institute of Technology, Radioactivity Center	998
Mather, G.	896
Matsuda, N.	897
Matsuki, T.	89
Matsuno, Y.	149
Matsushima, Y.	556
Mattern, H.	563
Matterson, L. D.	797
Matsumiya, S.	459
Mawson, C. A.	1145
Mayr, F.	1103
Mays, C. W.	364, 1146
Mazoué, H.	449, 451
Mazur, M.	973
Medlen, A. B.	99
Mednikyan, G. A.	999
Mehrhoff, N. R.	529
Meinke, W. W.	927
Mellander, O.	133, 134, 640
Melon, J.	732
Menden, E.	564
Mercer, D. N.	797
Merezhinskii, M. F.	668
Michelsen, O.	909, 910, 911, 912
Michigan State University	51
Michon, G.	1104
Michou, J.	725, 726
Middleton, L. J.	776
Migicovsky, B. B.	641, 642, 643, 644
Mika, E. S.	1020
Milhaud, G.	194
Miller, B. L.	1000
Miller, V. L.	586
Mills, R. C.	628
Milne, W. L.	170, 915, 938, 975, 1001
Minder, W.	401
Minzer, G. L.	826
Miranda, C. P.	798
Mitchell, H. H.	175, 469
Mitlin, N.	1002
Miyazaki, M.	645
Mole, R. H.	53, 980
Monroe, R. A.	212, 254, 815, 818
Montastruc, P.	722
Moor, J. R.	208, 255
Moore, J. H.	135, 136, 137, 406, 532, 533
Morgan, A.	913, 1126
Morgenthaler, P. W.	390
Mori, K.	149
Mori, T.	248
Morrell, E.	155, 583
Morrison, R. I.	113
Morrow, P. E.	277
Moschette, D. S.	113
Mosher, R. E.	1073, 1147
Mosiman, R. S.	327
Moskalev, Y. I.	790, 1067
Mosquera, G. V.	525
Mourgue, M.	453, 454
Mouriquand, G.	565
Muhlemann, H. R.	511

	Page
Mulligan, L.	659
Mulryan, B. J.	277, 403, 404, 568
Munson, P. L.	701, 718
Munson, R. J.	53
Muracciole, J. C.	758, 840, 841
Murai, E.	311
Murayama, M. M.	177
Murphy, W. R.	762
Mussett, A. V.	681c
Muthenthaler, H.	1123
Myers, G. B.	1147
Myers, H. M.	508
Nakajima, T.	566
Nakamura, I.	646, 647
Nassim, J. R.	659
National Academy of Sciences, National Research Council	950
National Research Council	52
Natucci, G.	567
Neary, G. J.	53
Neller, J. R.	198
Nelson, A.	17, 1038
Nelson, A. B.	153
Nelson, J.	1003
Nelson, M. M.	882
Nerurkar, M. K.	669
Nervik, W. E.	1105
Nesbitt, J. B.	1106
Neuman, M. W.	54, 55, 372, 568
Neuman, W. F.	54, 55, 210, 211, 277, 323, 372, 402, 403, 404, 405, 407, 413, 568
Newcombe, H. B.	951
Newlander, J. A.	781
New York Academy of Sciences	56
Nezvesky, L.	797
Nicolaysen, R.	569, 622, 623
Niedergerke, R.	278, 279
Nielson, A. M.	644
Nienberg, M.	530
Nishiyama, Y.	426
Nitta, H.	898
Nobel, S.	444
Nogier, A. L.	565
Nold, M. M.	83, 106, 141, 916
Nordin, B. E. C.	214, 234, 480
Norman, N.	1148
Norris, W. P.	92, 193, 235, 324, 486, 1091, 1092, 1149
Noyes, P.	91
Nozaki, H.	522
Numerof, P.	648
Nusbaum, R. E.	75, 130, 320, 321, 475
Nutlay, A. G.	744
Oak Ridge National Labora- tory	57
O'Dell, B. L.	619
Odell, T. T., Jr.	280
Odum, H. T.	481, 516
Oehlert, G.	990
Oliver, L.	336
Oliver, R.	1004
Olsson, N.	640
O'Neil, J. B.	521, 531
Onishi, N.	633
Ophel, I. L.	952
Ortelli, G. A.	1086
Ortiz de Landazuri, E.	687
Osborn, G. H.	1150
Osthelder, G.	862
Ottar, B.	909, 910, 911, 912
Outler, J. C.	783, 811
Overstreet, R.	181
Owen, M.	226, 314, 427, 1005

	Page
Pace, N.	178
Painter, E. E.	1007
Palancade, P.	891
Palmer, D.	1139
Papadopolou, D.	582
Parlier, R.	128, 736
Parrott, M. W.	173
Parsons, D. S.	131
Parsons, J.	461
Partington, J. R.	58, 59
Patel, J. C.	594
Patrick, H.	649, 650, 651, 680c, 899
Pattee, C. J.	22
Patterson, R. L., Jr.	928
Patwardhan, V. N.	607, 608, 631
Paupe, J.	281
Pearson, C. S.	577
Pearson, N. S.	255
Pearson, O. H.	678
Pecher, C.	93, 782, 799, 1060, 1061
Pecher, J.	799
Peeters, G.	800, 801, 802
Peets, E.	98
Perkovich, E. A.	652
Perrone, M.	1113
Pervinsek, W.	195
Petriello, L. I.	369
Petrovich, I. K.	1062
Petukhova, E. A.	653
Petzold, I.	1137
Phillips, G.	1151
Phillips, P. H.	886
Phillips, R.	1070
Picard, J.	412, 428a, 428b, 429, 430, 702
Pickering, D. E.	614, 654, 833
Pierce, J. A.	421
Pieruccini, R.	509
Piette, M.	721, 734
Pileggi, V. J.	585, 664, 860
Pille, G.	891
Pincus, J. B.	655
Pindborg, J. J.	763
Plancl, H.	722
Plastridge, W. N.	797
Plumlee, M. P.	116, 553, 554, 803, 830
Pobedinskii, M. N.	1063
Podoliak, H. A.	129
Polin, D.	523, 703, 704
Pollard, E. C.	60
Polyakov, V. A.	325
Ponomarev, P. P.	804
Porrata-Doria, E. I.	600, 601, 854
Porter, L. M.	1064
Porter, T.	728
Posin, D. Q.	236
Posner, A. S.	61, 892
Postel, S.	958
Potts, A. M.	958
Poulos, P. P.	237
Pounden, W. D.	627
Prasad, A. S.	282
Prelot, M.	700, 705
Pritchard, J. J.	482
Prokhonchukov, A. A.	510, 1006
Prosser, C. L.	195, 249, 1007, 1020
Pyrah, L. N.	238
Quimby, E. H.	997
Rabotti, G.	431
Raiha, C. E.	656
Ramage, H.	470
Ramfjord, S.	326
Randall, J. T.	10
Rand Corporation, Santa Monica, Calif.	953
Rao, K. P.	196

	Page
Raoul, Y.....	62, 700, 705
Ray, R. D.....	63,
327, 483, 570, 1008, 1009	
Raymond, W. H. A.....	219,
220, 1135, 1136	
Rayner, B.....	315
Reardon, J.....	1100
Reda, H.....	524
Reid, D.....	165
Reinhardt, W. O.....	761
Reisfeld, R. A.....	900
Remky, H.....	87
Rice, T. R.....	164
Rigamonti, L.....	745
Rinehart, R. W.....	915, 938
Ritter, R.....	266
Robertson, J. S.....	915, 938
Robertson, W. K.....	198
Robinson, R. A.....	354
Robison, R.....	328
Robuschi, L.....	609
Roche, A.....	454
Rock, T.....	431
Rodgers, A.....	648
Rogers, T. A.....	805
Roofe, P. G.....	1044
Rosenberg, M. L.....	373
Rosenberg, S. A.....	986
Rosengren, K.....	589
Rosenheim, A. H.....	328
Rosenthal, H. L.....	94, 95, 96, 239
Rosenthal, M. W.....	1097, 1107, 1108
Rosenthal, T. B.....	832
Rosinski, J.....	1152, 1153
Rossotto, P.....	746, 765
Roucaeyrol, J. C.....	201
Rounds, D. E.....	130, 320, 562
Rowland, R. E.....	322
Rubanovskaya, A. A.....	329, 571
Rubin, M.....	1109
Rubin, P.....	1010
Rubinson, A. C.....	186
Rudd, R. K.....	908
Ruf, F.....	374
Ruffo, A.....	746, 764, 765
Rupp, W.....	657
Russell, R. S.....	81, 954
Rust, J. H.....	842, 1048
Rutherford, Sir E.....	64
Rutishauser, E.....	375
Rygh, O.....	432, 572, 573, 670
Ryo, K.....	593
Saarinén, P.....	574
Sacher, G.....	240
Sadchikov, S.....	806
Sager, R. H.....	575
Sahasrabudhe, M. B.....	669
Saito, S.....	149
Sakurai, Y.....	645
Salem, H.....	524
Salerno, P. R.....	985, 986, 1011
Salvini, M.....	861
Samachson, J.....	97,
101, 241, 440, 1114, 1115	
Sanchez, F. S.....	525
Sándor, K.....	784
Sano, T.....	658
Sansom, B. F.....	776
Sapelkin, P. A.....	807, 808
Sarna, P. S.....	814
Saroff, J.....	698, 699, 742
Sarpenak, A. E.....	154
Sasaki, R.....	526, 809, 810
Sassaman, H. L.....	648
Sato, K.....	459
Sausen, R. E.....	197
Savchuck, W. B.....	433

	Page
Saville, P. D.....	659
Scardavi, A.....	527
Scendrate, R.....	371
Schaefer, A. E.....	648
Schaffert, R. R.....	1140
Schaible, P. J.....	139, 858
Scheer, K. E.....	660
Schicks, E.....	318
Schilling, A.....	242
Schilz, W. E.....	1154
Schjeide, O. A.....	747
Schmidt, D. A.....	893
Schmidt, H. J.....	455
Schneider, L.....	1064
Schnepf, E.....	863
Schofield, F. A.....	583
Schooley, J. C.....	905, 916, 1117
Schraer, H.....	576
Schraer, R.....	576
Schreier, K.....	563, 862, 863
Schubert, J.....	283,
284, 285, 286, 864, 1012, 1013,	
1014, 1098, 1110, 1111.	
Schubert, M.....	884
Schuch, R. L.....	933
Schulert, A.....	98, 943, 945
Schwartz, S. S.....	1064
Schwarzenbach, G.....	276, 287
Schweitzer, G. K.....	650, 651, 899
Sciellieri, G.....	434
Sciortino, G. B.....	434
Scott, K.....	181
Scott, K. G.....	614, 833, 1015
Sealander, J. A., Jr.....	901
Seibert, H. C.....	958
Sekikawa, A.....	706
Selye, H.....	679, 748, 766
Sen, S.....	671
Sen, S. C.....	671
Senda, H.....	902
Severinghaus, J. W.....	1155
Shannon, R. L.....	65
Shaw, J. H.....	332, 1112
Sheldon-Peters, J.....	1016
Sherman, H. C.....	577
Sherwin, J. C.....	170
Shikhodyrov, V. V.....	1065
Shikita, M.....	556
Shimanovskaia, K. B.....	996
Shirley, R. L.....	198, 528, 529, 530, 811
Shofield, F. A.....	155
Shorr, E.....	420, 424, 425, 435, 456, 895
Sicher, H.....	73
Sierens, G.....	802
Sierens, R.....	801
Signorelli, E.....	765
Silberberg, M.....	767, 834
Silberberg, R.....	767, 834
Silberstein, H. E.....	1017
Simmons, E. L.....	667, 988, 1066
Singer, L.....	99
Sipovskii, P. V.....	330
Sissons, H. A.....	1005
Skirmont, E.....	1057
Skupp, S.....	1139
Slater, T. F.....	786, 787, 788
Slesareva, E. N.....	484
Slovik, N.....	440
Smith, A. H.....	38
Smith, R. H.....	661
Smith, R. M.....	288
Smith, V. R.....	707, 708, 709
Snyder, R.....	962
Sobel, A. E.....	416,
418, 436, 437, 438, 439, 440,	
441, 442, 443, 444, 457, 458,	
578, 655, 843, 1156.	
Sognnaes, R. F.....	331, 332

	Page
Solncev, A. I.....	812
Solntsev, A. I.....	812, 813
Solomon, A. K.....	199
Soloway, S.....	199
Somogyi, J. C.....	511
Sowden, E. M.....	485
Spain, P.....	130,
319, 320, 321, 475, 562	
Spargo, B.....	575
Spear, F. G.....	66
Speckman, T. W.....	193, 235, 486
Spector, W. S.....	67
Spencer, H.....	97,
100, 101, 107, 241, 243, 542,	
1095, 1113, 1114, 1115, 1116	
Spencer, M. C.....	68
Sperti, L.....	752a
Spicer, G. S.....	80, 913, 1126
Spielman, A. A.....	797
Spiers, F. W.....	955
Spinks, J. W. T.....	521, 531
Spode, E.....	200
Sprows, R. G.....	156
Squire, H. M.....	776
Stanbury, J. B.....	753
Stangle, E.....	289
Steadman, L. T.....	232
Stearner, S. P.....	667
Stearns, R.....	321, 475
Stedman, D. E.....	570
Steenbock, H.....	585,
600, 601, 602, 605, 606, 626,	
662, 663, 664, 854, 860.	
Steere, A. C.....	845, 846
Stein, I.....	69
Steiner, R. L.....	487, 488, 489, 490
Stephens, S. V.....	70
Stevenson, F. H.....	659
Stitch, S. R.....	485
Stone, R. S.....	1058
Stott, G. H.....	707, 708, 709
Stover, B. J.....	76,
102, 244, 245, 246, 253, 298	
Strandh, J. R. E.....	685
Strehler, E.....	247
Streletssova, V. N.....	1067
Strohl, A.....	201
Sturkie, P. D.....	523, 704
Stuttgen, G.....	202, 203
Suenaga, M.....	89
Suga, K.....	259
Sugawa, I.....	123, 124, 1090
Sugita, T.....	566
Sullivan, M. F.....	1018
Sullivan, R. L.....	987
Sulon, E.....	882
Sumi, M.....	459
Sündararajan, T. A.....	814
Surmont, J.....	1019
Susbielle, H.....	876, 877, 878, 879, 880
Sutton, A.....	555, 1136
Suyehiro, Y.....	248
Suzuki, M.....	149
Svensson, S. A.....	579
Svetovidov, A. N.....	125, 229
Svihla, G.....	195
Swanson, E. W.....	254, 815, 818
Swarm, R.....	1010
Swell, L.....	903
Swernov, J.....	107, 542
Swift, M. N.....	249, 1007, 1020
Swingle, K. F.....	478
Swoboda, W.....	657
Szoke, K.....	835
Taddei, I.....	865
Taha, M. M.....	866
Takahashi, K.....	248

	Page
Takei, Y.	522
Talmage, R. V.	710,
711, 712, 713, 714, 715, 716,	717, 1080, 1117.
Tanimoto, T.	151
Tardy, N.	878, 879
Tarjan, R.	835
Taupitz, E.	906
Tausky, H. H.	1157
Taylor, J. F.	146, 552
Taylor, T. G.	406, 532, 533
Taysum, D. H.	306, 1146
Teeri, A. E.	597
Tellekson, B. J.	984
Thomas, I.	400
Thomas, R. O.	138
Thomas, V.	191, 192
Thomas, W. C., Jr.	445, 665a
Thompson, R.	1118
Thompson, T. G.	103, 1129
Thomson, D. M.	213, 825, 836, 1009
Thornton, P. A.	139
Thurber, D. L.	104
Tibbetts, D. M.	964
Tikekar, P. G.	594
Tillman, A. D.	153
Tinsley, M.	1064
Tipton, I. H.	487, 488, 489, 490
Todde, I.	1119
Tomiyama, T.	140, 250
Tomkins, P. C.	195
Tomlin, D. H.	376, 377, 378, 379, 406
Toribara, T. Y.	277, 403, 404, 1128
Torok, A.	363
Torres, R. N.	512
Toverud, S. U.	718
Townsend, R. O.	550
Townslay, S. J.	108, 166, 182, 914
Treadwell, A. de G.	380
Treadwell, C. R.	903
Tredwell, C.	557
Tretheway, H. C.	219, 220
Troesch, F. M.	86
Troshin, A. S.	125, 229
Trout, E. C., Jr.	903
Trueman, E. R.	491
Trum, B. F.	916
Trusova, N. E.	1068
Tsao, M. U.	1158
Tsujimura, Y.	158
Tsukamoto, Y.	248
Tsurufuji, S.	311, 503, 504, 556
Tsuzuki, M.	1021
Turekian, K.	476, 492
Turk, E.	1159
Turner, C. W.	698, 699, 742, 821
Tutt, M.	226, 228, 251, 315
Tutt, M. L.	1120
Tweedy, W. R.	719
Tyler, C.	135, 136, 137, 534, 535
Tyler, S. A.	252, 816
Uhler, K.	68
Ullberg, S.	84
Underwood, E. E.	398

	Page
United Nations Scientific Com-	
mittee.	929
U.S. Atomic Energy Commis-	
sion.	333, 930, 956, 957
U.S. Atomic Energy Commis-	
sion, Technical Information	
Service.	72
Upton, A. C.	280
Urist, M. R.	50,
334, 580, 747, 749, 750	
Ushakova, V. F.	329, 571
Utah University, Radiobiology	
Laboratory.	1022
Vallee, B. L.	1003
Van Alstine, H. E.	205
Van Atta, R. E.	1131
Vanbelle, M.	15
Vancini, B.	672
Van Cleave, C. D.	105
Van Den Hende, A.	800
Van der Wal, P.	493
Van Dilla, M. A.	253, 298, 306, 1003
Van Heusden, E. G.	446
Vankinseott, V.	1116
Van Middlesworth, L.	309, 335, 381
Van Nieuwenburg, C. J.	494
Van Os, G. A. J.	290
Vasil'eva, E. N.	904
Vaughan, J.	226, 228, 251, 314,
315, 1004, 1005, 1016, 1023	
Vaughan, J. M.	1120
Vehe, K. L.	312
Verne, J.	201, 336
Verzár, F.	827, 828
Villette, H.	634
Vincent, J.	495
Vinikova, B. G.	999
Virtama, P.	496
Visek, W. J.	212, 254, 815,
817, 818, 837, 838, 839, 842	
Vogeleisen, A.	740
Volchok, H. L.	1160
Volkov, D. T.	819
Volwiler, W.	738
Wadhvani, T. K.	447, 497
Wager, H. P.	789
Wainwright, W. W.	513
Wakisaka, G.	89, 123, 124, 1090
Walker, A. R. P.	581
Walker, C. W.	707
Walker, D. G.	754
Walker, D. M.	540, 541
Wallace, H., Jr.	864
Wallace, J.	1064
Wampler, J. M.	104
Wanner, R. L.	255
Ward, A. A., Jr.	483
Ward, A. H.	256,
257, 978, 979, 980, 1024	
Ward, G. M.	771, 792, 820
Wase, A. W.	752b, 755, 756, 757
Wasserman, R. H.	13,
14, 81, 82, 83, 84, 106, 126,	
141, 382, 582, 905, 916.	

	Page
Waterhouse, D. F.	498
Watson, J. C.	146, 552
Webb, M. S. W.	80
Weese, K.	1069
Weidmann, S. M.	682
Weikel, J. H., Jr.	405, 407
Weinmann, J. P.	73, 422, 514, 744
Weissberger, L. H.	665b
Weits, J.	666
Welford, G. A.	922
Weller, H.	291
Welsh, J. H.	199
Wetzel, E.	246
White, V. K.	479
Whitney, I. B.	85, 922, 923
Widdowson, E. M.	233
Wiest, W. G.	664
Wietek, F.	906
Wilbur, K. M.	448
Wilke, C. F.	537
Williams, D. E.	155, 583
Williams, E. F., Jr.	120
Williams, J. B.	355
Williams, M. H.	173
Williams, R. J. P.	74
Williams, W. F.	821
Williamson, B. J.	216, 258
Wilson, C. W.	1025, 1026
Wiltshire, L. L.	170
Wise, M. B.	157
Wohinz, R.	515
Wojta, H.	408
Wolff, A. H.	931
Wolff, N. K.	570, 1009
Wolterink, L. F.	139, 142, 858
Woodard, H. Q.	1027, 1028, 1070
Woodruff, L. A.	1091, 1092
Woods, K. R.	720
Wortley, G.	954
Worton, A. G.	584
Wöstmann, B. S. J.	595, 596
Wright, N. C.	822
Yamamasu, T.	123, 124, 1090
Yamamoto, D.	337
Yonezawa, T.	259
Yoshimine, Y.	89
Yoshimoto, S.	158
Yoshino, S.	248
Zak, B. W.	1161
Zander, G. E.	960,
992, 993, 1029, 1030, 1049	
Zannelli, C.	870
Zatti, P.	752a
Zetterstrom, R.	358, 613
Zhivkov, V.	823
Zhizhina, N. A.	907
Zilversmit, D. B.	815
Zipkin, I.	845, 846
Zittle, C. A.	908
Zotti, R.	509
Zucconi, C.	147



